MASSACHUSETTS
AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 453 AUGUST 1949

# Annual Report

For the Fiscal Year Ending June 30, 1949

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The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

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UNIVERSITY OF MASSACHUSETTS
AMHERST, MASS.

# MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

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Yegian, Hrant M., Agronomy

•In charge †At East Wareham ‡At Waltham §On Military Leave

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## CONTENTS

# ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION—1948-49

## DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

### A. H. Lindsey in Charge

**Fluid Milk Prices in Major Northeastern Markets.** (A. A. Brown, H. G. Spindler, V. A. Reising, and J. A. Ward.) Attention has been centered on the historical relationship of prices between Worcester and Springfield, Worcester and Boston; between Springfield and Boston; and between Springfield and New York. The basic data developed for Springfield and Worcester have been obtained from reports and audits in the files of the Massachusetts Milk Control Board. The analysis of the relationship of the New York and Boston markets is being developed by the staff of the New England Research Council.

For Worcester and Springfield the following work has been done:

(a) Prepared market summaries of receipts and sales by months for 1945.

(b) Determined relationship between farm-to-plant transportation rates and distances from farm to plant.

(c) Determined respective milksheds on a town basis.

(d) Computed monthly weighted average prices paid to producers for the period 1945-1948.

(e) Prepared and published "Selected Statistics, Springfield Milk Market (Area 6A) June and November 1948." This publication includes summaries of receipts and sales, and a computation of weighted average prices based on net utilization of receipts from producers.

Post-war difficulties are evident in the Springfield and Worcester markets. Differences in blended prices between markets, together with the wide disparity between Class I and Class II and between Class I and blended prices in each market, have been principal factors creating unstable situations. The sharp drop in the Class II prices in the fall of 1948 resulted in unusually wide spreads between the class prices and producer prices and has given rise to the problem associated with unequal costs of milk to dealers in the same market.

**Marketing of Hatching Eggs.** (A. A. Brown, B. E. Brown, and J. A. Ward.) Analysis to date of the marketing operations of broiler-hatching egg producers discloses two points that may be usefully developed. One pertains to breed; the other to alternative market outlets.

During the curtailment period that developed in the fall of 1948, about two thirds of the flock owners shipping broiler-hatching eggs received notices to discontinue or reduce shipments. Of these flock owners 79 percent had their pens mated Rock-Reds, straight Rocks, or mixtures. The balance of this group was divided between straight Reds (8 percent) and Rock-Hamps (13 percent). Among flock owners who did not receive curtailment notices pens were mated as follows: Rock-Hamp and Hamps (45 percent), Rock-Red and Reds (36 percent), other combinations (19 percent). The data indicate that when cutbacks are made in orders, shippers of Rock-Hamp or Hamps are in the least vulnerable position; but that shippers of good strains of Rock-Reds may not fare too badly.

Analysis was also made of the changes that occurred in receipts of "nearby" eggs at Boston during November and December 1948. The results are not conclusive. More detail is desirable. The data indicate, however, that the moderate

shifts that occurred in the movement of broiler-hatching eggs were highly overrated as a cause of the break in egg prices. The situation suggests that if the small net volume involved did precipitate a downward trend, the organization and structure of the market is woefully defective.

**Egg Marketing Through Wholesale Channels.** (A. A. Brown, R. W. Brundage, and J. A. Ward.) This study was conducted on a regional basis in cooperation with PMA, BAE, and several of the other Northeastern States. A joint report is being prepared at Cornell.

Within Massachusetts the wholesale market appears to handle, as closely as can be estimated at the moment, one third of the eggs annually produced on Massachusetts poultry farms. The balance of the production going into market-egg channels is sold directly by poultrymen to jobbers, institutions, stores, retail route operators, and consumers.

The wholesale market is further differentiated seasonally. Its location and structure vary according to changes in the size of the "nearby" supply. During the months of heavy production the wholesale market for "nearbys" actually exists. In the short season, wholesaling, as commonly considered, is very limited. Throughout the entire year, however, the volume of nearby eggs being sold outside the market is substantial and poses a problem relative to the adequacy of current pricing methods.

Some attention was given to pricing methods and price reporting in this study. The results served as a basis for developing a study on "Egg Pricing in the Boston Market."

**Marketing of Massachusetts Potatoes.** (R. A. Fitzpatrick, A. A. Brown, and J. A. Ward.) The survey of permanent potato storage facilities in producing areas in Massachusetts, which was made in 1948, has revealed an increase in the use of storage. The survey showed that there were 62 operators, having 84 storages with a total capacity of over 900,000 bushels, equivalent to 30 percent of the commercial crop. The wider use of winter storage dates from the mid-war years, and has resulted largely from two influences; viz., the effects of interregional competition, and the price support program.

Before the war, Massachusetts produced a crop of early potatoes which amounted to about 45 percent of the State's annual production. This crop was marketed after the heavy shipments from the Intermediate states, and before the marketings from the Surplus Late states. Continuing pressure from outside areas producing a similar crop had narrowed the local marketing advantage, and a trend toward greater production of late varieties was in progress. The price support program, effective with the 1943 crop, accelerated the shift toward late potato production, and to the accompanying development of storage operations. During the latter years of the war, the early varieties had declined to about 30 percent of the total State production.

Associated with both storage and price support has been an increasing emphasis on cultural practices aimed at increased yield per acre. Thus, while the total acreage in the State showed a downward trend after 1943, yield per acre was rising. The wide use of machinery and commercial fertilizer, and generally favorable weather effected, in 1948, the highest average yield per acre in Massachusetts history. The result was that although the total acreage in 1948 was 34 percent below that of 1943, total production in 1948 was only 5.4 percent smaller than that of 1943.

The trend toward production of more late potatoes may be of long-run nature. If this assumption is correct, the use of winter storage must become a permanent

feature of local marketing practices. It is evident from the storage survey that some producers and dealers have committed themselves to the regular use of storage facilities. This development accentuates some existing marketing problems and creates others.

The study has thus far determined the characteristics of the supply of local potatoes, and has described and evaluated the development of winter storage. The work in progress involves a detailed analysis of distribution of the local crop, and a phase of this work is concerned with a survey of potato-buying practices of retail-store operators.

**Production Adjustments on Representative Massachusetts Farms.** (B. D. Crossmon.) Farm management case studies are under way on 32 Massachusetts farms. Information has been secured showing the organization and practices on all farms, while so far detailed budgets have been prepared for eight farms. These indicate the enterprise structure, physical inputs and outputs, and receipts and expenses for a selected base period. The profitability of proposed adjustments on these eight farms has been pointed out by using the budgets as a base and making appropriate modifications to prices, to combination of enterprises, or to rates of using input factors.

Farms so far selected for study have been in the Connecticut Valley area of Hampden and Hampshire Counties, in Worcester County, in Plymouth County, and in Barnstable County. To date, the two types of farming receiving the most study have been dairy and cranberries. Part of the dairy farms in the Connecticut Valley area were chosen in cooperation with the BAE, USDA, as a part of a regional study on possible cost reduction. The cranberry growers are concerned with the costs of typical bog operations.

Follow-up visits with the county agent to five dairy farms studied in Hampden County showed farmer movement toward the more profitable alternatives budgeted. The adjustments tended toward the increased herd production of several thousand pounds per farm shown as possible in the proposed budgets. Improved roughage, use of artificial breeding and barn re-arrangement to save labor were other current adjustments. Adjustments on these farms have been considered in college teaching.

Five case write-ups were made during the year and copies supplied cooperating farmers, county agents, and the State Extension office. These will later be combined with others into an Experiment Station publication. These data served as the basis for two articles: (1) "A Farmer Looks Ahead," in Farm Economic Facts, March 1949; (2) "The Farmer Gets Pinched," in Farm Economic Facts, June 1949.

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## DEPARTMENT OF AGRICULTURAL ENGINEERING
### H. N. Stapleton in Charge

**Forage Handling Investigations.** (H. N. Stapleton and Earle F. Cox.)

*Barn Hay Drying.* The work on high volume fans to supply unheated air for mow drying has been continued. As previously reported, the investigation of fans suitable for use with electric motors of 7½ HP or less has been the primary consideration. On the four installations in the mows at the University Farm it has been impossible this season to impose water loadings approaching the calculated evaporative capacity of the fans. On all of the installations, hay has cured satisfactorily. The driest June of record at this Station produced hay which went on the driers at 28-38 percent moisture, with 2 to 4 hours in the swath and windrow.

One high, narrow mow 12 feet by 24 feet received 17 tons of hay which produced an initial depth of 25 feet. The static pressure on the side main serving the slatted floor at no time exceeded 5/8 inch water column. The air supply was provided by a 3 HP 42-inch 2-blade propeller fan which a cooperating manufacturer has developed, on the basis of our previous reports and current recommendations.

Test work with the blast-tunnel has indicated that if maximum delivery is to be obtained from manufacturer's stock fans, the fan tip must be adjusted for minimum practicable clearance from the mounting ring. The desirability of using a variable pitch pulley for the motor, to obtain final adjustment of the drive was shown by the data which developed that percentage loss in air delivery from underspeed is greater than the percentage of underspeed. The test work on 3-phase motors operating on single-phase input for this application will be made the subject of a later report.

**Air Conditioning of Animal Shelters and Crop Storages.** (H. N. Stapleton and Earle F. Cox.)

*Improvement of Poultry House Ventilation.* The study of the application of fan ventilation to poultry houses was begun in an attempt to find a more satisfactory means of litter-moisture control, and to evaluate other incidental benefits.

Tests the past season have shown that heat balance calculations developed according to standard ventilating practice provide a satisfactory basis for predicting the performance of the fan ventilating system. When climatic conditions and the insulation provided in the structure permit pen temperatures in excess of 40° F., the heat available from litter decomposition in deep litter and from solar radiation may be almost as great as the sensible heat available from the birds with present poultry management practice. The regulation of pen temperature with varying outdoor temperatures is most easily accomplished by thermostatic control of the amount of fan delivery.

Data from recording hygrothermographs showed that the most efficient use is made of available heat when the fan inlet is placed in the dropping pit, if this item of equipment is used. When one of several pens is fan-ventilated, moisture movement from adjacent pens is measurable, both in the air and litter condition of the pens and in the moisture load of the air moved by the exhausting fan.

Work with cooperating farmers indicated that litter replacement stored under cold conditions before introduction into the pen can bring excessive moisture with it. One farmer changing litter weekly was found to be introducing apparently dry but cold shavings at 38 percent moisture into his pens after removing wet litter which tested only 32 percent moisture.

**Warm Room Brooding.** (Earle F. Cox.) To reduce the room temperature which developed from the use of a wall-mounted pipe panel and to obtain a more accurate measurement of the heat input, the hovers were modified by the addition of electric resistance heating elements. Within the brooder area the inclined hover surface increased the degree of vertical temperature gradient. With the upper edge of the inclined hover attached to the wall, stratification within the hover area developed so that satisfactory floor temperatures could not be obtained. When fans were installed to reduce the stratification, some heat pockets still remained with excessive velocities developed at the floor.

A recording voltmeter indicated that a voltage of 106 was frequently encountered. Therefore, it was felt that a true measure of the merits of using electric resistance heating elements on inclined hovers could not be made until a higher and more uniform voltage was used. Corrective measures are in process.

## DEPARTMENT OF AGRONOMY
### Dale H. Sieling in Charge

**An Improved Method for Determining the Phosphate-Fixing Capacity of Soils.** (Dale H. Sieling and Garland B. Bass.) Most methods for determining the phosphate-fixing capacity of soils are long and tedious; present many difficulties in manipulation; and require special reagents and a centrifuge to effect a complete removal of excess phosphate before the fixed phosphate can be replaced and determined.

It is rather well established that *active* iron and aluminum are largely responsible for the fixation of phosphates in acid soils. For this reason it was believed that these components of the soil might be extracted from the soil by a selective solvent and that, after separation from the soil, they could be determined quantitatively to give a value for phosphate-fixing capacity which would compare favorably with that obtained by the more tedious and time-consuming direct method. In a previous report it was shown that *active* iron and aluminum are easily complexed and rendered soluble by the citrate anion. This complexing was so effective that these metal ions could not be precipitated by either phosphate or hydroxyl ions as would normally take place in the absence of the complexing anion. Citric acid was therefore chosen as the selective solvent for extracting the *active* iron and aluminum.

Samples of several soils, with a wide range of phosphate-fixing capacities as determined by the direct method, were extracted with citric acid under several sets of experimental conditions with regard to temperature, time, and concentration of the reagent. For the several soils tested in this preliminary experiment to establish the ideal conditions for the determination, values obtained for phosphate-fixing capacity of soils closely approximated those determined by the direct method, when the following procedure was used. Twenty grams of soil were extracted with 75 ml of 0.5 molar citric acid by heating for one hour in a boiling water bath, filtering immediately, and washing the residual soil 6 to 7 times with hot water. The filtrate and washings were collected into a volumetric flask and appropriate aliquots were removed for the determination of the extracted iron and aluminum after the organic matter was destroyed and the silica dehydrated by digestion with a nitric acid–perchloric acid mixture.

The combined iron and aluminum content of silica- and organic-free extracts was determined quantitatively by a special method developed in this study. This method is based on the fact that iron and aluminum may be precipitated quantitatively with phosphate at pH 3.4 in the absence of complexing anions and without interference from other cations which would be present in soil extracts. The advantage of this method is that equivalent quantities of iron and aluminum react with like quantities of phosphate, thus allowing simultaneous determination of the two elements as a single fixing agent for phosphate without regard to the actual content of each. The total phosphate content of the precipitate formed at pH 3.4 and thoroughly washed with 1 percent NaCl solution to remove adsorbed phosphate is determined colorimetrically after the precipitate is dissolved in dilute perchloric acid.

The principal advantages of this extraction method over the direct method for determining the phosphate fixation of soils are (1) a larger, more representative sample of soil is used; (2) less than one-half as much time is required for each determination; (3) the difficulties encountered in washing the unreacted phosphate from the soil in the direct method are eliminated; (4) the active constituents responsible for the fixing process are converted to a pure inorganic chemical system after removal of interfering substances—in this form they can be deter-

mined accurately and rapidly; and (5) no special laboratory equipment is needed for the determination.

The phosphate-fixing capacities of 40 soils from Maine, Vermont, New Jersey, North Carolina, Alabama, and Massachusetts were determined by this proposed method and by the direct method. The values obtained in each soil by the two methods were practically the same, even though the range of the fixing capacities varied from 5–80 millimols per 100 grams for the different soils.

**Release of Fixed Phosphates by Organic Anions as Influenced by pH.** (Dale H. Sieling and Paul H. Struthers.) It has previously been reported that certain organic anions were effective in replacing phosphate which had been chemically combined with iron and aluminum as basic phosphates. All of these replacement reactions were carried out at the pH of maximum precipitation of the basic phosphates—pH 3.0 for iron and pH 4.0 for aluminum. Since these pH values are below those normally found in agricultural soils it seemed advisable to determine how effectively certain of these anions would replace the chemically combined phosphate at pH values throughout the range from pH 3.0 to 8.0 for iron and pH 4.0 to 9.0 for aluminum. These were the pH ranges for iron and aluminum which were effective in fixing a considerable portion of soluble phosphate and covered the entire range of pH's of agricultural soils.

The anions of citric, oxalic, malonic, tartaric, lactic, succinic, malic, aspartic, and alpha amino propionic acids were used as replacing anions. One millimol each of iron or aluminum phosphate and of the replacing anion were mixed in a definite volume and the pH of the mixture was adjusted to the desired value with sodium hydroxide. After boiling for one-half hour the amount of phosphate chemically combined with the iron was determined. By this procedure a measure of the relative affinity of the phosphate and the organic anion for the iron or aluminum at different pH values was obtained and it gave a value for the replacing ability of the anion.

It was found that the two amino acids, aspartic and alpha amino propionic acid, were not effective in replacing phosphate at any pH value. Citric acid was most effective for iron at pH 4.8 to 5.0 and for aluminum at pH 5 to 6. Citrate was the most effective anion tested and was more active in replacing phosphate from basic aluminum phosphate than from basic iron phosphate. Malic acid was most effective at pH values 4 to 5 for both iron and aluminum; while oxalic acid showed greatest replacing power at pH 3.0 for iron and at pH 4.0 for aluminum. Malonic acid was most active at pH 4.0 for the aluminum system but showed equivalent replacing ability for phosphate from the iron salt throughout the entire pH range from 3 to 8. Lactic acid was effective to a greater degree at pH's above 6 than below for both iron and aluminum. Tartaric acid showed the greatest effect at pH 4.0 for basic aluminum phosphate and at pH 3.0 for basic iron phosphate.

In addition to this systematic investigation of the various anions, it has also been observed that galacturonic acid is a very effective phosphate replacer. Pectic acid obtained by dilute alkali hydrolysis of pectin was also found to be very active in phosphate replacement and in complexing iron. Since pectin is found in all plant residues it seems reasonable to assume that it might have a very important role in preventing phosphate fixation in soils and in mobilizing iron and aluminum. The fact that as much as one-third of the organic matter of some soils is in the form of uronides may account for the fact that phosphate fixation is less severe in soils of high organic content than in others. It is conceivable that the uronides have been the effective mobilizing agents in the transfer of iron and aluminum to the $B_1$ horizon of podzols since this is the zone of accumulation of uronides as well as of iron and aluminum.

**The Availability to Plants of Applied Phosphorus as Influenced by the Presence of Organic Materials and Fluoride.** (Dale H. Sieling and Glenn C. Russell.) Plants were grown in pot culture on a soil known to have a high phosphorus-fixing capacity and a low phosphorus content. Phosphorus was applied to the pots at rates equivalent to 80, 120, and 160 pounds of $P_2O_5$ per acre as control treatments. Other pots at the 80-pound level were treated with spent hops, citrate, or fluoride. Results showed that the applied phosphorus resulted in greater phosphorus uptake although growth was not improved over controls. In pot culture with no drainage the use of 200 p.p.m. of fluoride proved toxic.

Plants were grown in sand culture with basic iron and aluminum phosphates as the source of phosphorus. Phosphorus in this form was applied in the same quantity as the phosphorus applied as $KH_2PO_4$ in Knop's nutrient solution in the control cultures. Cultures were set up with ten and twenty times the basic level of phosphorus of the controls. Cultures at the lowest level were also treated with citrate and fluoride. Growth and phosphorus uptake at the low level of phosphorus were poor, but were improved by the use of citrate and fluoride. Fluoride at the rate of 10 p.p.m. did not prove toxic to germination or growth. Cultures containing ten times the initial level of phosphorus gave better growth but not equivalent to that of the control. Phosphorus at twenty times the initial level resulted in growth and phosphorus uptake comparable to that of the control.

Actively decomposing organic matter results in more effective use of applied phosphorus in soils by the production of organic acids, some of which form stable complexes with iron and aluminum, thus releasing fixed phosphate or preventing its fixation. The action of one of these organic acids is illustrated by the effect of citrate on phosphorus uptake even though the citrate was applied in small quantities. The use of fluoride to replace fixed phosphate in soils would not be practical, because fluoride in sufficient quantities to appreciably increase the effectiveness of applied phosphorus would be toxic. Basic iron and aluminum phosphates, when present in very large quantities, release enough phosphorus by hydrolysis to produce normal growth.

**Value of Spent Hops from Breweries as a Source of Organic Matter for Use in the Growing of Turf.** (Dale H. Sieling, L. S. Dickinson, and Moyle E. Harward. Cooperating Agent: P. Ballantine and Sons.) Results from studies made to date give definite indication that spent hops have value as a pre-seeding amendment to sandy loam, silt loam, and clay loam soil. Comparisons were made with soils treated with peat moss and cultivated peat and checks. Before an application of fertilizer was made, the stimulation of growth was very marked on the hops plots. After fertilizer applications, the influence of the fertilizers remained more than three weeks longer on the hops plots than on all other plots. Field plots treated in December remained smooth and without cracks throughout the following spring, while other areas were heavily cracked. Very favorable results have also been obtained with hops as a greenhouse mulch for roses and gardenias. Further studies are warranted, particularly as to the value of hops as a top-dressing on turf to furnish organic nitrogen, also as a conditioner and source of organic nitrogen in commercial fertilizers.

**The Absorption of Chemical Elements by Plants.** (W. S. Eisenmenger and Karol J. Kucinski.) There is some belief that the chemical composition of rocks from which soils are weathered determines the relative amounts of plant nutrients that are taken up by plants grown upon these soils. Seven different species of plants which had grown on four different soil series were collected for chemical analysis. The soils, of the Dover, Gloucester, Holyoke, and Cheshire series, were

chosen because they had weathered from rocks having a wide difference in chemical composition—limestone, granite, basalt, and sandstone, respectively. The areas from which the plants were picked had never been fertilized or cultivated. Based on the calcium and magnesium content of these plants, the soil series ranked in descending order as follows: Holyoke, Dover, Gloucester, Cheshire. Based on phosphorus content, the rank in descending order was Dover, Gloucester, Holyoke, Cheshire; but the differences in phosphorus content of the plants on the different soils was not great.

**Magnesium Requirements of Certain Plants.** (W. S. Eisenmenger and Karol J. Kucinski.) Because of the expanding building program on the University Campus, the original magnesium deficiency plots have had to be abandoned. However, the topsoil from the deficient plots to plow depth was moved to another area after the topsoil at the new location had been scraped off. Plants grown on these plots showed definite symptoms of magnesium deficiency, which were most severe on the unlimed portion of the area.

Studies of crop yields and chemical analysis of soils from various parts of western Massachusetts indicate that the soils which are weathered from triassic sandstone furnish less magnesium to plants than soils weathered from granite, limestone, or basalt. It may be generally concluded that soils with a high pH (6 to 6.8) are quite fertile and plants grown on them seldom show symptoms of magnesium deficiency.

**Tobacco Quantity and Quality Following Early Fall Application of Nitrogen Fertilizer.** (W. S. Eisenmenger and K. J. Kucinski.) Tobacco was grown on an area where corn had been grown the previous year. On one-half of the area corn was harvested before plowing; on the other half, the corn plant was plowed under. The purpose was to study the effect on the tobacco of the residual fiber from the corn crop.

Nitrate of soda was applied in the early fall, to supply 0, 50, 100, or 200 pounds of nitrogen per acre; and tobacco was planted on the area the following spring. Where 50 pounds of nitrogen was added, there was no increase of yield or crop index[1] over the control. Where the corn was plowed under and 100 pounds of nitrogen added, the yield and crop index were about the same as for the control; but where the corn was harvested and 100 pounds of nitrogen added, the yield and crop index were markedly increased. Where 200 pounds of nitrogen was added, the crop index and yield were increased by about 10 percent.

**Trials with Cutting, Management, and Nitrogen Fertilization of Timothy.** (Wm. G. Colby.) Timothy is by far the most important hay grass grown in Massachusetts. Within recent years, increasingly large amounts of complete commercial fertilizers have been applied to haylands to increase the yield of hay and also to improve the feeding quality. In years of abnormally high rainfall in the spring, the growth of grass may be so rank and lush by haying time that excessive lodging frequently occurs. Losses from lodging and increased difficulty in curing the hay frequently nullify the beneficial effects of the fertilizer. In an attempt to develop a practical system of management which would eliminate or at least substantially reduce lodging losses, a series of plots was laid out on a year-old timothy stand during the summer of 1948. All plots were limed and liberally fertilized with superphosphate and potash. The two variables studied were the time and amount of nitrogen applied and the time of cutting. The first year's results indicate that lodging can be substantially reduced (1) by applying nitrogen in the late fall or early spring and cutting the hay early—about the first or

[1] Crop Index is the term used for a single figure which combines grading quality and yield.

second week of June; and (2) by applying nitrogen after the first crop of hay, cut at full-bloom stage, has been removed.

Sixty pounds of elemental nitrogen applied July 1, 1948, produced a second or rowen crop of approximately two tons to the acre compared with slightly over three-fourths of a ton from the check. These results were obtained even though the rainfall for the months of July, August, and September was much below normal. Sixty pounds of nitrogen applied in the spring of 1949 produced at the rate of 3600 pounds per acre on the early-cut series of plots compared with 2025 pounds on the checks.

**Breeding Work With Orchard Grass.** (William G. Colby.) Further plant selections were made from plantings of the Finnish late hay strain of orchard grass. Several of these plants approach the writer's conception of the ideal orchard grass type for use in the Northeast. They are late maturing. Maturity dates for individual plants range from one to two weeks later than the maturity dates for commercial strains. These plants have stiff leafy stalks of medium height with many of the leaves arising high on the stalk. No serious injury has as yet been observed from leaf spot diseases. Progressive tests are being conducted to determine breeding behavior, winter hardiness, and other characteristics. A space-planted nursery of 7500 plants was started last summer with the hope that more plants with as good or even better growth characteristics can be solated.

**Strain Trials with Smooth Brome Grass.** (William G. Colby.) Some of the more common strains of brome grass including Elsberry, Achenback, Fisher, Lincoln, Martin, and Canadian Commercial were grown in association with Ladino clover. Seeding was done in August, 1947. The spring of 1948 was cool and wet with the result that all six strains made rank growth and then lodged badly. Much of the Ladino clover was killed by smothering. There is need for a stiff-stalked strain of smooth brome grass of medium height which is more lodge resistant than any strains now available.

**Red Clover Variety Trials.** (William G. Colby.) These trials, conducted for several years in cooperation with the U.S.D.A. Bureau of Plant Industry, have demonstrated the superiority of Kentucky selection (recently named Kenland) over all other strains of red clover tested. To gain further information on the adaptability of Kenland red clover, one hundred pounds of seed were distributed to cooperating farmers in different sections of the State.

**The Improvement of Havana Seed Tobacco.** (C. V. Kightlinger.) This project is concerned with the improvement of Havana Seed tobacco in disease resistance, type of plant, type and quality of leaf, and productiveness; also improvement in cultural and management practices to enable farmers to raise the improved strains with greatest benefit both to themselves and to cigar manufacturers.

Work is under way to breed strains that are highly resistant to mosaic and wildfire, as well as to black rootrot. It is the aim to incorporate high resistance to all three diseases into the same strain. It is, however, with the black-rootrot problem that most progress has been made to the present time.

A few strains of Havana Seed tobacco have been developed that yield well and produce tobacco of excellent type and quality, both under favorable growing conditions and under black rootrot promoting conditions, as well. Havana 211, Havana K1, Havana K2, and Havana K2-24 are the best of the new strains produced so far; and of these, Havana K1 and Havana K2-24 seem to have gained

the general preference of both the farmers and the tobacco trader. Other strains are being developed which at the present stage promise to be superior to those already produced.

The first of the improved strains of Havana Seed tobacco was introduced for farmers' use in 1933. Since that time the use of the improved strains has increased steadily. Conservative estimates indicate that at least 75 to 80 percent of the total acreage of Havana Seed tobacco in the Connecticut Valley at the present time is planted to these strains. The average annual yield per acre of Havana Seed tobacco in Massachusetts was 240 pounds higher for the period 1933–1947 than for the twelve years preceding 1933—an increase attributable largely to the resistance of the new strains to black rootrot. It is thus evident that the use of these improved strains has been profitable to our tobacco growers.

**Effects of Fertilizing Tobacco Seedbeds in the Fall and in the Spring.** (C. V. Kightlinger.) It has been the purpose of this experiment to compare the effects of fall fertilizing and spring fertilizing with organic and inorganic fertilizers on the germination of seeds and the subsequent growth of plants in tobacco seedbeds sterilized with chloropicrin and in those not sterilized.

The experimental plots in the seedbed were 12 feet long by 6 feet wide. The fertilizers used were 6-3-6 tobacco fertilizer and 5-8-7 inorganic fertilizer, applied at the rate of 12 pounds per plot or slightly more than 166 pounds per 1000 square feet. This rate of application is heavy, but not more than many farmers use regularly.

*Fall-Fertilized Plots.*—Germination of seed and subsequent growth of plants were very good on the sterilized plots; in contrast, while germination was very good on the unsterilized plots, subsequent growth of plants was very slow. There was little difference between the effects of the two kinds of fertilizer. The difference between the growth of the plants on the sterilized and unsterilized plots, however, plainly showed the value of sterilizing tobacco seedbed soil.

*Spring-Fertilized Plots.*—Germination was very poor on all plots, regardless of the kind of fertilizer used and whether or not the soil had been sterilized. The few seedlings that lived grew very slowly at first, but later, apparently after the fertilizer had lost its harmful effects, they grew rapidly. For some reason not fully understood, germination was a little better on the unsterilized than on the sterilized plots. On the sterilized plots, the tobacco fertilizer gave slightly better germination than the inorganic. There was little difference in the subsequent growth of the few seedlings that survived on any of these plots. The germination of seed and the stand of plants were so much better in the fall-fertilized than in the spring-fertilized plots that the value of fertilizing tobacco seedbeds in the fall was clearly shown.

The general conclusion from this experiment is that it definitely pays to sterilize tobacco seedbeds and to fertilize them in the fall.

**Tests of Spray Materials for the Control of Late Blight of Potatoes.** (C. V. Kightlinger and H. M. Yegian.) The materials tested in comparison with Bordeaux mixture (5-2½-50) were Dithane 14, Dithane Z78, and neutral copper (yellow cuprocide), applied in spray form in accordance with the recommendations of the manufacturer. All the materials were applied at the rate of 150 to 175 gallons of spray per acre. The experimental plots were one-thirtieth acre in size. All plots, including the check plots to which no fungicide was applied, were replicated four times. The Green Mountain variety of potatoes was grown. They were sprayed weekly from mid-June until frost killed the vines, except in mid-

season when they were sprayed every five days for a short period. DDT and nicotine were used as needed to control insects.

All three of the materials tested gave acceptable control of blight and were more convenient to use than Bordeaux. Dithane Z78 was without question as effective as the Bordeaux mixture in its control of blight, and Dithane 14 and yellow cuprocide were little if any less effective. None of the three materials had any noticeable depressing effect on the growth and development of the potato vines, while the depressing effect of the Bordeaux mixture was very noticeable.

**Potato Variety Trials.** (Karol J. Kucinski and Ralph W. Donaldson.) Varieties of potatoes tested in 1948 with respect to their yielding qualities ranked as follows: Pontiac, 580 bushels; Green Mountain, 542; B61-3, 513; Sequoia, 489; B76-43, 476; Kennebec, 468; Houma, 457; Sebago, 441; Katahdin, 407; Cobbler, 341; Teton, 332; Chippewa, 326; White Rose, 315; Markota, 213; Mohawk, 202; Erie, 188; and Pawnee, 175.

**Soil Conservation Projects.** In Cooperation with the Research Division of the Soil Conservation Service, United States Department of Agriculture. (Karol J. Kucinski, Project Supervisor.)

*Effect of Loss of Topsoil on Crop Yields.*—In order to illustrate the value of topsoil and organic matter, a field experiment was initiated in 1942, in which the topsoil to plow depth was totally removed from a plot, while an adjacent plot was left undisturbed as a check. Portions of both plots have been fertilized annually, while the remaining portions have received no fertilizer. The crops grown have been spring wheat, white sweet clover, buckwheat (twice), winter rye, and oats. The decrease of crop yield due to topsoil removal ranged from 24 to 81 percent on the fertilized plot, and from 52 percent to complete crop failure on the unfertilized plot.

*Fertilization of Beach Grass.*—Beach grass plots at Sagamore were top-dressed with varying amounts of fertilizers of different ratios, to see whether it is possible to increase stands of beach grass for use in propagation work in the stabilization of sand dune areas. Application of a complete fertilizer (with one-half of the nitrogen from organics) at 500 to 1000 pounds per acre has given promising results. Inorganic nitrogen top-dressing alone has produced exceptionally good propagating stock of beach grass.

*Investigation with Various Winter Cover Crops for Onion and Potato Fields.*—An intensive program was initiated last fall by the various agricultural agencies in the Connecticut Valley to promote the use of winter cover crops. The results were most gratifying, with nearly all farmers in the Valley cooperating.

Various winter cover crops were seeded at weekly intervals during the fall to determine dates for seeding of the crops to produce a desirable mat to prevent wind and water erosion during the fall and winter months. Because of the exceptionally mild winter, oats and barley did not winterkill, and desirable cover was produced when they were seeded not later than the last week of October. Rye and winter wheat produced satisfactory stands when they were seeded before the second week of November.

*Farm Fish Ponds.*—In New England, farm fish ponds are a new venture, and very little is known about the yield and rates of growth of self-propagating fish in this area. Several ponds are being constructed at the Experiment Station for study of the various phases of the subject, and additional ponds with private ownership are being used to enlarge the scope of the study.

**Irrigation Studies and Management of Irrigated Soils.** (Karol J. Kucinski, Herbert N. Stapleton, and Dale H. Sieling.) Tobacco, truck, and dairy farmers in Massachusetts are showing considerable interest in portable irrigation systems. There is some indication that the increase in crop yield, the insurance against crop failure, and the improvement in quality of product will justify the cost of installation and maintenance.

Studies have been initiated to investigate all phases of supplemental irrigation as it applies to the various kinds of crops, fertilization, changes in soil structure, and effect on diseases and pest control, as well as to yields and quality of crops. The cost of installation and maintenance is being investigated in cooperation with the Department of Agricultural Engineering.

**Field Tests with Magnesium.** (Karol J. Kucinski.) For a good number of years we have been studying the importance of magnesium in plant nutrition, and considerable information has been gathered with respect to the requirements of various species of plants for this element. The academic aspect of the functions of magnesium as a plant food, although not always satisfactorily answered, have been thoroughly investigated and the results generally accepted. Corrective measures for areas showing extreme symptoms of magnesium deficiencies have been accepted by the farmer. However, it has been felt for some time that, in farming areas where plants do not show extreme symptoms of magnesium deficiency, the soil may yet be lacking in magnesium for optimum plant growth and maximum crop yields. Accordingly, a series of field trials was undertaken during 1948 in cooperation with several farmers, using various field crops grown on different soils.

All plots received a liberal application of a complete fertilizer. Certain plots received in addition a magnesium supplement: either 200 pounds per acre of Epsom salt or Sul-Po-Mag, or 2 percent of MgO included in the fertilizer as a soluble salt. The crops were potatoes, field corn, ensilage corn, carrots, and pasture. All crops showed increased yields on the magnesium-treated plots. Field corn showed the least increase, 3 to 10 percent; ensilage corn, the highest, 56 to 68 percent. Potato vines remained alive and green longer on the plots receiving magnesium, and increase in yields was sufficiently pronounced to be readily noticeable as the potatoes were being harvested.

The results of these trials on soils with a seemingly adequate supply of magnesium point strongly to the false economy of not including 30 to 40 pounds of magnesium oxide in soluble form per ton of commercial fertilizer which is to be used for growing vegetable or field crops on alluvial or glacial outwash soils.

**The Control of Onion Diseases by Fungicidal Chemicals.** (Hrant M. Yegian.) Bacterial soft-rot and fusarium bulb-rot are the most destructive diseases of set onions in storage. For many years Connecticut Valley onion growers have sustained heavy losses from these two diseases. The organisms causing these diseases are commonly found in cultivated soils, especially those on which onions have been grown continuously for many years. They are most troublesome if the weather is rainy during the latter part of the growing season, more particularly during the time of harvesting. Immature onions, big fleshy bulbs, or thick-necked bulbs are especially susceptible to infection.

During the past four years, various fungicidal chemicals, Fermate, Puratized N5E, Isothan Z-15, Wettable 604, Wettable Spergon, Dithane D14 and Dithane Z78 were tested for the control of storage rot. The chemical compounds were applied in water solution as sprays three times at weekly intervals before the crop was harvested. They were also used as dipping solutions soon after the bulbs were topped. In either case there was no evidence that any of the fungicides was effective in controlling storage rot.

In most instances infection of the bulbs takes place through the wounds at the neck of the topped onions or through the damaged leaves and roots. The glabrous surface of the onion leaf does not retain enough of the fungicidal chemical for effective protection nor are the causal organisms in the soil killed by the chemicals. This may account for the failure of the treatments to control storage rot of onions.

**The Inheritance of Certain Characters in the Onion.** (Hrant M. Yegian.) During the 1948 season, crosses were made between new male-sterile lines furnished by U.S.D.A. and selected strains of our Ebenezer lines. Production of breeding stock and maintenance of pure lines were continued.

$F_1$ hybrid sets from the previous crosses were tested. One of the combinations, (5114 x 8512) x Massachusetts line 87 was very promising. It produced at the rate of 730 fifty-pound bags of No. 1. onions per acre. The bulbs were firm, globe-shaped, and had bright yellow skin. On March 15, 1949, under ordinary storage conditions, it had a total of 17 percent sprouted bulbs and only 2 percent neck-rot. Bulbs from Massachusetts 87 were sent to Mr. Peter Oleson, Crookham Company, Caldwell, Idaho, who was here to see the hybrid onion test and was interested in the performance of this line. They propose to use it in their hybrid onion seed production program.

**The Evaluation and Use of Flint Lines in Flint-Dent Corn Hybrids.** (Hrant M. Yegian.) Two new experimental hybrids, (CC4 x CC8) x (A96 x Z83) and (CC4 x CC8) x (NY3 x Q83), were introduced this year by this Station. These are early-maturing field corn and are considered to be an improvement over Mass. 62 which has been favorably received by farmers in Massachusetts and a few of the other Northeastern States.

Last year 45 all-combination single crosses involving 10 early-maturing inbred lines were produced with the objective of finding an early-maturing flint-dent hybrid. One of the important characteristics of flint lines in flint-dent crosses is the ability to hasten maturity from 5 to 10 days—a very desirable factor in areas where the growing season is cool and short.

Results of tests of 23 commercial hybrids and 7 experimental hybrids were reported to the cooperating seed dealers.

**Black Substances as Soil Amendments.** (John W. Everson and Roy Sigafus.) Where black non-nutrient substances such as charcoal, lampblack, or soot have been added to soil, crops have shown favorable responses. A study was made of water evaporation and soil temperature to determine whether the addition of non-nutrient black caused enough physical change in the soil to account in part for crop response.

Small surface applications of black, 400 pounds per acre, were effective. Evaporation increased with large additions; but when the amount used produced a mulch, evaporation was lowered. When mixed in the upper two inches of the soil, at least ten times as much black was required to produce the amount of evaporation produced by a surface application. Surface application is not practical because of blowing or washing away.

Through the growing season the maximum temperature was raised approximately two degrees and the minimum lowered half a degree. This widens the thermoperiodic effect and so has the same effect as advancing the season in the spring.

The use of carbon black as a soil amendment, however, is not recommended because of its cost and the fact that it is difficult and disagreeable to handle and tends to blow away when applied to the surface of the soil.

## DEPARTMENT OF ANIMAL HUSBANDRY
### Victor A. Rice in Charge

**A Study of the Mineral Elements of Cows' Milk.** (J. G. Archibald.) The work with nickel has been completed. Nickelous chloride (500 mg. daily) was fed as a supplement to the rations of six cows for a period of two months, by the double reversal method. Analyses of numerous samples of the milk showed varying amounts of nickel. However, when the milk was kept from contact with metal by milking directly into glass jars, nickel was not present. It was therefore concluded that nickel is not a constituent of natural milk and that the varying amounts found in the course of the investigation came from the milking machine.

A manuscript entitled "Nickel in Cows' Milk" has been accepted for publication in the Journal of Dairy Science.

**A Study of Quality in Roughage: Composition, Palatability, and Nutritive Value of Hays as Affected by Curing, Harvesting, and Storing Procedures.** (J. G. Archibald, M. L. Blaisdell, and H. N. Stapleton.) The work has consisted of two phases: (a) A biochemical study of the changes which take place in hay during the curing process and in storage, and of how these changes are affected by different methods of curing; and (b) feeding trials with milking cows of some of the lots of hay studied under (a). Tentative conclusions are:

1. Of the chemical constituents studied, carotene and sugar were subject to the most loss in the hay curing process. Carotene losses were extensive both in the field and after storage, beginning almost as soon as the hay was cut and continuing for weeks or even months in storage. Sugar losses were relatively unimportant in the field but were frequently extensive in storage, especially in hay that had been stored too damp.
2. Losses in protein, crude fat, and ash were relatively unimportant unless the hay had been exposed to excessive and/or repeated rainfall; after storage these constituents were affected little if any.
3. Carotene and sugar losses were appreciably less in barn-dried hay than in field-cured hay, provided the blower installation was adequate.
4. Feeding trials with eight cows, extending over a period of four months, showed no differences in milk yield as a result of feeding hay averaging 6.1 percent sugar in contrast with hay averaging 3.9 percent of sugar. All of the "high-sugar" hay had been barn-dried; most of the "low-sugar" hay had been field-cured.
5. Although it is admitted that the differences in these lots of hay, from the standpoint of appearance, composition, and palatability, were much less than the differences often encountered in practice and under our own observation; nevertheless, it is felt that the practice of barn-drying hay has much more to recommend it from the standpoint of speeding up hay making and saving hay from spoilage by weathering, than it has from the standpoint of improved nutritive value of the hay.

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## DEPARTMENT OF BACTERIOLOGY
### Leon A. Bradley in Charge

**Bacteriological Study of Sewage Sludge.** (James E. Fuller.) In a previous report on this project (Mass. Agr. Expt. Sta. Bul. 449, p. 18, 1948) it was noted that *Escherichia coli* survived longer in drying sludge stored at 37° C. than at room temperature of about 22° C. Subsequent study has indicated that 30° to 32° C. is a more favorable temperature than 37° for survival of *E. coli* in drying

sludge. This is near the temperature maintained in digestion tanks of sewage disposal plants.

The previous report indicated that the disappearance of *E. coli* from the drying sludge appeared to be the result of a combination of several factors; viz., lack of a readily available source of nutrient materials, unsuitable temperature, and inability to compete with other types of bacteria better suited to the environmental conditions. Subsequent study has indicated that the drying sludge contains ample nutrient materials but they are not in a chemical form simple enough to be available to *E. coli*. Other bacteria in the drying sludge can and do digest these nutrients to simpler states, but the process is slow and the products of the digestion are quickly utilized by the hardier types of bacteria present in the sludge and little is left for the less hardy *E. coli*.

Since the results of the experiments indicate that *E. coli* will disappear in a few weeks from sludge drying on a filter bed, it is highly probable that any pathogenic intestinal bacteria present would disappear even more quickly because they are less hardy than *E. coli* outside of the body or fresh feces. Bacteria that normally are found in the bodies of human beings and other warm-blooded animals are accustomed to body temperature and readily available food materials. These conditions do not obtain in drying sludge where the basic biological principle of survival of the types best suited to the environment is operative. Thus, it is reasonable to assume that well-digested sewage sludge which has been air-dried on a sand filter bed should be safe for use as a fertilizer even on garden soil, particularly if it is plowed into the soil before the crops are planted.

Sludge has much humus value, particularly when it is mixed with sandy soil. There is some nitrogen which soil bacteria will make available for crop use, and there are also some mineral salts. Since animal manures are comparatively scarce in many places, it would seem desirable to utilize this material if it can be proved hygienically safe. This study is a contribution in that direction.

**Survival of Escherichia coli from Sewage in Soil of Septic Tank Disposal Fields.** (James E. Fuller.) It has been reported previously (Mass. Agr. Expt. Sta. Bul. 446, 1948) that few *E. coli* isolations could be made from the soil of a septic-tank disposal field, even though the septic-tank effluent discharged into the soil contained ample quantities of the organism. The coliform types recovered from the soil were mostly those common in the soil of the field that received no sewage effluent. The recent work on this project has been a study of these coliform types isolated from the soil. A great deal of variability was encountered in their cultural behavior. Many which produced gas in lactose broth (the primary test employed for detection of coliform bacteria in water) when first isolated from soil promptly lost that capacity after their isolation. This capacity could be restored in some of these cultures but not in many of them. Other cultural reactions commonly employed to differentiate coliform types from one another proved to be unstable and variable. These results raise two questions:

1. Does *E. coli* in an unfavorable environment tend to change by mutation into coliform types that are not typical of the sewage type? This has been claimed by some investigators, and soil is definitely a less favorable environment for *E. coli* than are feces and sewage because soil contains less moisture and readily available nutrients, the soil temperature is more variable, and there is great competition for nutrients from bacteria that are native to the soil and that consequently are more at home in it.

2. Granted the disappearance of typical sewage-type *E. coli* from soil, how valid is the commonly accepted test for *E. coli* in evaluating the sanitary quality of raw waters? Should the laboratory insist on the presence of *E. coli* in such

tests and ignore the presence of other coliform types? Should search be made for other criteria of sewage pollution of water?

The work projected for the next year on this project will aim to find the answers to these questions, or some of the answers at least.

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## DEPARTMENT OF BOTANY
### A. Vincent Osmun in Charge

**Diseases of Trees in Massachusetts.** (M. A. McKenzie, A. Vincent Osmun and D. H. Marsden.)

*The Dutch Elm Disease Problem.* New laboratories for studies of shade tree problems were completed in February, 1949, and are now operating with special attention to investigations of Dutch elm disease. From July 1, 1948, to June 24, 1949, the Dutch elm disease was found in 40 additional towns, making a cumulative total of 134 since the disease was first known here (1941, Alford, Berkshire County). Summarily, in laboratory studies by means of tissue plantings in artificial culture media, the disease fungus, *Ceratostomella ulmi* (Schwarz) Buisman, has been isolated from 3478 trees in 11 of the 12 counties on the mainland; Barnstable, Dukes, and Nantucket being reported disease-free at present. With notable isolated exceptions, the build-up of the disease is greatest in the Connecticut Valley and west of this area.

River valleys are natural sites for heavy reproduction and growth of elms, and generally they attain greatest size here. Accordingly, in such regions the number of weed elms may be excessive in contrast to the number of cared-for elms in areas where elms appear principally as shade and ornamental trees. Town tree maintenance programs vary widely throughout the State in the extent to which elms may be kept relatively free of dead material, and the degree to which the disease progresses locally may be closely allied to these community conditions. Additional considerations in disease spread involve failure to carry out control measures at the proper time. Essential sanitation work may be delayed for the sake of convenience or necessity if the potential cost of such tragic neglect is overlooked temporarily. A sound program of tree care, which is important for elms independent of the threat of Dutch elm disease, is imperative in disease control programs. Good intentions and procrastination are poor substitutes for constructive action, and with few exceptions local intensification of the disease may be ascribed to the absence of timely sanitation work. In this connection the greatest need of the program to control Dutch elm disease in Massachusetts is active participation by local tree departments.

The possibility that the use of spray materials to restrict vectors of the disease fungus may be a valuable adjunct to disease control by sanitation methods is under investigation in cooperative studies with the Department of Entomology. Considerable progress has been made experimentally, but many phases of this subject require additional study. Similarly, studies of disease resistance in elms require additional fundamental work.

As part of a program with the Massachusetts Department of Agriculture, elms found to be diseased in a scouting project are reported to municipal tree departments, property owners, or other agencies responsible for trees involved. In local disease control programs of 25 cities and towns where diseased trees or other elm material which might contribute to the spread of the disease have been cut and burned, the average increase in number of diseased trees locally has been reduced. This relative control varies from effective checking of disease spread in

adequately alerted towns to somewhat unsatisfactory disease checking in less fortunate places.

Eleven progress reports (mimeographed) and eight press releases were sent out during the year.

*Other Tree Problems.* Forty-six diseases of twenty-two species of trees including eight diseases of elms were identified from more than 800 specimens and inquiries received during the year. The Cephalosporium wilt of elm, which under certain conditions may resemble the wilting of foliage common with Dutch elm disease, was found widely throughout the State. Next in order of incidence was wilting of woody plants in association with the fungus, *Verticillium* sp.

Field observations of two other tree diseases previously reported briefly were continued this year and inquiries concerning both the dying of oaks and the occurrence of bronzed flags on maples have been numerous. A fungus tentatively identified as *Valsa* sp. was found most commonly in association with cankers on affected branches of maples, but no studies of its pathogenicity have been made. No further evidence of the cause for death of oaks has been found.

The death of several acres of hemlock was investigated, and the injury appeared to be associated with drought. Certain other species of plants died out completely on a rocky ledge in the area. No significant fungus or insect damage was observed.

A disease of mockorange (*Philadelphus* spp.) in which individual canes die, has occasioned numerous inquiries recently. Limited investigations have shown the trouble to be extremely common. In fact, few plants, if any, are totally free from it. The cause remains to be determined.

The severe midsummer drought of 1948, which extended into the autumn, caused damage commonly known as sun scorch on foliage widely throughout the State. Maples in particular were severely affected.

Winter injury was only slight or lacking this year. In fact, injury to flower buds of trees valued for their floral displays, such as dogwood (*Cornus* spp.), was so slight that they were at their best this spring, even in parts of the State where winter conditions often preclude profuse blossoms.

**Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modifications of Environment.** (W. L. Doran.) It was found that Japanese elm, like American elm and some Asiatic elms, can be propagated by softwood stem cuttings taken in June and treated with indolebutyric acid. This method was unsuccessful with the Buisman elm, a variety of *Ulmus carpinifolia* which is resistant to the Dutch elm disease; but that elm was successfully propagated by root cuttings taken in March and inserted, untreated, with the proximal ends projecting above the rooting medium. On the basis of this work, an article by W. L. Doran and M. A. McKenzie on "The Vegetative Propagation of a Few Species of Elms" was prepared and has been accepted for publication in the Journal of Forestry.

As treatments of the seeds of red pine in a forest nursery in May, Semesan gave better results, better stands than did Arasan, Zerlate, Spergon, or Phygon. With Phygon, the results were inferior to those with untreated seeds.

December cuttings of hemlock, *Tsuga canadensis*, made of wood of the current year rooted in larger percentages than did similar cuttings which were so made as to include, at the base, wood two or three years old. Best rooting, 80 percent, was of cuttings of one-year-old wood treated with indolebutyric acid 100 or 200 mg./l., 22 hours.

In work with root-inducing substances and fungicides, used together or separately, there were indications that Phygon (2, 3-dichloro 1, 4-naphthoquinone)

is useful and safe with cuttings of several species and that it hastens the resumption of growth of rooted cuttings of some.

Spergon, used as a powder dip on the base of cuttings, was apparently injurious to *Cotoneaster horizontalis*, *Daphne cneorum*, and hemlock. Phygon similarly used, without indolebutyric acid, improved the rooting of cuttings of Cotoneaster, Daphne, and *Picea glauca conica*. Rooting of November cuttings of Cotoneaster and hemlock was more improved by Phygon preceded by solution-immersion treatment with indolebutyric acid than by the latter used alone. And September cuttings of *Chamaecyparis obtusa nana* rooted in larger percentages when Phygon and naphthaleneacetic acid were used together than when the latter was used alone. September cuttings of *Picea glauca conica* rooted in twice as large percentages with Phygon alone as they did without treatment. December cuttings of hemlock rooted more rapidly after treatment with indolebutyric acid 100 mg./l., 19 hours and Phygon than after treatment with indolebutyric acid alone. Rooting of January cuttings of Cotoneaster was better with Phygon alone than with indolebutyric acid or indolebutyric acid and Phygon used together.

Since the coming into use of root-inducing substances, a principal problem is to induce rooted cuttings of some species to resume top growth. It was interesting to observe, therefore, that cuttings of Daphne treated with indolebutyric acid followed by (powder-dip) Phygon began to make new growth earlier than did untreated cuttings or those which had been treated with indolebutyric acid alone.

An article on "Low-growing Shrubs" by W. L. Doran was published in the Flower Grower 36:3:272-273. 1949.

**Diseases of Plants Caused by Soil-Infesting Organisms, with Particular Attention to Control Measures.** (W. L. Doran.) Fungicides were applied to soil in a 5-8-7 fertilizer (15 to 16 gm. per square foot) used as a carrier. Rates of application are in all cases expressed in grams of the fungicide or soil amendment per square foot of soil surface. Soil was treated immediately before seeding.

Onion smut caused by *Urocystis cepulae* Frost was prevented by 0.6 gm. of Arasan, Tuads, Phygon, or Fermate; but the best growth and least damping-off of onion seedlings was with Tuads or Arasan (tetra-methyl thiuram disulfide). There was 50 percent smut on onion seedlings in untreated soil, none with the above listed treatments, and growth of plants was much improved by them.

Arasan 1.0 gm. or Tuads 0.7 gm. gave slightly better control of damping-off of beet and tomato in limed soil than in unlimed soil. Stands of cabbage seedlings were improved by potassium chromate 0.44 gm.; those of lettuce by Phygon 0.65 or Tuads 0.65 gm. Damping-off of cabbage seedlings was better controlled by Phygon (2,3-dichloro 1,4-naphthoquinone) 0.7 gm. than by Arasan 0.7 gm.

Clubroot of cabbage caused by *Plasmodiophora brassicae* Wor. was not well controlled by 0.7 gm. of Arasan, Tuads, or Phygon in unlimed soil with a high moisture content. There was 100 percent clubroot in untreated soil, 38 percent with Tuads.

Clubroot of cabbage was not controlled by hydrated lime alone nor by mercurous chloride 0.2 gm. alone. But when they were used together, they gave good control; 13 percent clubroot in treated soil, 100 percent clubroot in untreated soil.

In another instance, the severity of clubroot was reduced by hydrated lime 25 gm., and the disease was entirely prevented by this application of hydrated lime used with mercurous chloride 0.35 or 0.4 gm. Mercuric chloride similarly used caused some injury to growth, and both salts were safer in limed than in unlimed soil.

Soil moisture is a factor, cabbage clubroot being easier to control with mercurous chloride and hydrated lime in a drier soil than in a less dry soil. In a limed soil, otherwise untreated, there was 78.1, 86.2, or 100 percent clubroot when this soil was watered to 50, 65, or 80 percent saturation, respectively. When mercurous chloride 0.3 gm. was applied to such limed soil, there was no clubroot in soil watered to 50 percent saturation, 7.4 percent in soil watered to 65 percent saturation, and 16 percent in soil watered to 80 percent saturation. Control was slightly less good when 0.2 or 0.25 gm. mercurous chloride was used, but in the least moist soil there was only 6.2 percent clubroot with 0.2 gm. mercurous chloride.

**Tobacco Frenching.** (L. H. Jones.) The work of the past year has been directed to ascertaining the causes of the variations in the strength of the so-called frenching factor in different soils, possible preventive and curative measures, diagnostic procedures to distinguish nitrogen-deficiency symptoms from frenching symptoms, the susceptibility of unrelated plants to the frenching factor, and the attempt to grow iron-deficient tobacco plants in sand culture. Two journal articles on frenching were published.

Experience has shown that one soil, in particular, was quite consistent in producing frenching in 5 to 12 days at a soil temperature of 95° F. However, this soil never produced frenching when air-dried, autoclaved one hour at 15 pounds steam pressure, or maintained at a soil temperature of 70°. Other soils, either compost or field, have not proved so efficient in producing frenching at the arbitrary soil temperature of 95° and produced none at all at the soil temperature of 70°. The frenching factor, suspected of being a micro-organism, appears to be more intense once it has been built up in the soil. Slow-reacting soils will react more quickly if inoculated with soil that has recently produced frenching.

It has previously been reported that the frenching symptoms result, apparently, from the inability of the plant to obtain a sufficient amount of iron, because of the competition of soil organisms for this element. An organic iron substance, ligno-sulfonate, was mixed with a soil subjected to a frenching temperature. Frenching was not prevented, but it was sufficiently delayed to warrant further tests with this material.

In cooperation with the Bureau of Plant Industry, a frenching soil was sent to Beltsville, Maryland, for testing. Samples of the soil taken before shipment and samples sent back to Amherst from Beltsville produced typical frenching symptoms, and correspondence from Beltsville indicated that frenching was obtained there from this particular soil.

As yet there has not been developed a quick and specific test that will distinguish the early symptoms of frenching from those of nitrogen deficiency. If a dark blue color is obtained by testing the cut midrib of a leaf suspected as having frenched with a sulfuric acid solution of diphenylamine, this is a positive test that eliminates nitrogen deficiency as a cause of the symptoms. The diphenylamine is a test for nitrates. A negative test would still leave uncertainty. While frenching symptoms have been obtained in less than 15 days, the shortest period to obtain similar nitrogen-deficiency symptoms was 26 days during the month of June. With shorter days and cooler temperatures, September, October, and November, the average number of days to obtain the interveinal pinhead chlorosis with 8 plants was 40 days, with a minimum of 30 days and a maximum of 58 days. Such nitrogen-deficiency symptoms were preceded by extreme chlorosis of lower leaves, the dying (firing) of the lowest leaves, and a marked retardation of growth. The similar pinhead chlorosis of frenching was not preceded by any observable symptom. The plants grew rapidly, as would be expected at

the high soil temperature of 95° F. At the time the symptoms appeared the lower leaves were usually a normal and healthy green. The first appearance of the pinhead chlorosis that was symptomatic of frenching was at the tip of a forming leaf. Succeeding leaves appeared with more accentuated symptoms, grading between and from the pinhead chlorosis symptom to the distorted sword shape, strap-leaf, or rosette of filiform leaves.

An attempt was made to separate frenching symptoms from nitrogen-deficiency symptoms on the basis of moisture content of the leaves. The moisture content of normal leaves was about 70 percent; of nitrogen-deficient leaves 87 percent; and of frenched leaves 93 percent. In a previous experiment the moisture content of frenched leaves was 84 percent. From these figures it does not seem possible that a moisture determination of fresh-picked leaves could serve as a diagnostic procedure to separate frenching and nitrogen deficiency symptoms.

Frenching has been reported as a disease of petunia. Tests with this plant failed to produce frenching symptoms at a high soil temperature. However, some of the plants were affected by a virus which produced a chlorosis and, to some extent, narrowed the leaves. This virus was present in plants in both the low and high soil temperatures. It is possible that the report of frenching on petunia failed to take into consideration the virus factor which was true of the frenching of tobacco many years ago.

On the other hand there was obtained evidence that ragweed (*Ambrosia artemisiifolia* L.) is subject to a physiological malady similar to the frenching of tobacco and induced by the same environment of a high soil temperature. The newer foliage became chlorotic and the segments of the leaves stringlike.

While high soil temperatures may be responsible for poor growth of carnation plants during the warmer months of the year, no evidence was obtainable that this plant was affected with any symptoms comparable to temperature-induced frenching of tobacco. Carnation plants at the high soil temperature of 95° F. were less sturdy, had less dense foliage, and were subject to an earlier death of the lower leaves than were the plants at the lower soil temperature of 70°. There was no evidence of chlorosis or other color differences which are characteristic of frenching or mineral deficiencies.

**Iron-Deficient Tobacco Plants in Sand Culture.** (L. H. Jones and E. H. Bitcover.) In an effort to compare iron-deficient tobacco plants with those showing frenching symptoms, tobacco plants were grown in sand cultures. The nutrient solution supplied to check cultures contained iron in the form of ferrous sulfate. Cultures were grown at the root temperatures of 70° and 95° F., as well as at the ordinary but varying greenhouse temperature. In no culture was there obtained what would be considered symptoms of iron deficiency. Although the sand was washed and pure chemicals employed to make up the nutrient solution, the tobacco plants apparently obtained all the iron necessary for normal development. The cultures at 95° utilized a great deal more water (25 liters) than did the cultures at 70° (10 liters) or the cultures at the greenhouse temperature (9 liters), although to all appearances the growth of the tobacco plants was nearly equal in all cases.

**Tomato Leaf Mold Caused by the Fungus Cladosporium fulvum Cke.** (E. F. Guba, Waltham.) Successive generations of hybrids of English tomatoes X Improved Bay State, and English tomatoes X Marglobe have been selected for desirable commercial type and resistance to tomato leaf mold. These hybrids derived their resistance to leaf mold from *Lycopersicum pimpinellifolium*, Plant Introduction No. 112,215 from Ecuador, S. A. The effort is intended to provide a wider assortment of leaf-mold resistant tomatoes.

A hybrid of *Lycopersicum esculentum* var. Prince Borghese X *L. peruvianum* (immune) outcrossed to Pan America by W. S. Porte (U. S. Department of Agriculture), designated 44B292, has been pure-lined for immunity to leaf mold and distributed to interested investigators. In anticipation of the appearance of a new race of the pathogen with a higher level of virulence than existing strains, Bay State and 44B292 have been crossed to provide a successor for such an eventuality.

**Search for Inherent Resistance to Tomato Late Blight Fungus.** (E. F. Guba, Waltham.) In the previous annual report (p. 25), it was stated that some types of tomatoes among a collection of approximately 200 primitive types indigenous to Central and South America were found to be immune to infection by the fungus *Phytophthora infestans* (Mont.) de Bary. These tomatoes were inoculated with the fungus from tomatoes from Florida, and from potatoes from Ontario, Canada, the latter considered to be a virulent tomato strain of the fungus.

These promising blight-resistant tomatoes were grown on a large scale in the winter of 1948-49 and subjected to similar conditions of inoculation but with inoculum from a local greenhouse planting of tomatoes. None of the tomatoes survived the inoculations. Another tomato, designated T-5, from Dr. W. T. Schroeder, New York State Agricultural Experiment Station, and asserted to be resistant to *Phytophthora infestans* (Mont.) de Bary is susceptible to the disease. This report concludes this project.

**Causes and Control of Decay of Squash in Storage.** (E. F. Guba, Waltham.) A rather complete collection of winter varieties of squash was grown in 1948. The squashes were stored in the greenhouse and the kinds of decay peculiar to each were recorded. Bacterial wilt rot and black rot caused by *Erwinia carotovora* and *Mycosphaerella citrullina* represented the most common types of decay.

**Resistance to Fusarium dianthi Prill et Del., the Cause of a Serious Carnation Wilt Disease.** (E. F. Guba, Waltham.) Some 75 seedlings, hybrids of disease-resistant parents, were shared with Patten and Company and Sim Carnation Company, Inc., for evaluation and further screening. Several of these seedlings are considered to have very promising commercial value and are being propagated on a large scale. The two concerns have furnished the originator with characterizations of all the seedlings submitted for appraisal. The new seedlings should get into the trade after two years.

More new seedlings will be available this year. The plan is to direct the carnation industry away from Virginia types, which are highly susceptible to disease and which have been a factor in significant losses from disease in recent years, and to provide new types resistant at least to *Fusarium dianthi* and *Alternaria dianthi*.

**Control of Diseases of Greenhouse Crops.** (E. F. Guba, Waltham.) In a study of the control of carnation stem rot and wilt diseases in the greenhouse by chemical soil treatments, the following fungicides have been considered: Copper 8-Quinolinolate; Fulex Soil Treatment B, having copper 8-quinolinolate as the active base; the thiocarbamate fungicides such as Parzate, Fermate, and Z-78; phenyl mercuri acetates such as Puratized Apple Spray and Tag 331; and other types of fungicides such as Malachite Green, Spergon, Phygon XL, and Thiosan. All of these chemicals were toxic to the spores of carnation pathogens, but only the mercury fungicides were bactericidal. When an excess of spore material and mycelium or slivers of rotted tissue infested with *Rhizoctonia*, *Fusaria*, and bacteria were immersed in an aqueous mixture of chemical, the action was fungistatic rather than fungitoxic. The concentration of the chemical was also a factor.

In the presence of soil, none of the chemicals was toxic at customary concentrations used in spraying plants. When large ratios of chemical powder to soil were mixed and moistened with water, disinfestation of nematodes and fungi was positive, but bacteria were not destroyed. In a descending series of ratios of chemical to infested soil, Fermate and Phygon outlasted the others; and in a ratio of about 12 pounds of chemical to a bed 100 by 4 feet by 6 inches (13 grams to 819 cubic inches), only Phygon was fungicidal but neither nemacidal nor bactericidal.

Fundamental studies suggest that fungicidal and disinfesting ratios of chemical and soil could be realized more readily by mixing chemical and soil before planting rather than by surface applications of the chemical in water after planting. By the latter method the toxic ratio of chemical and soil in the surface, theoretically, could be reached only after several applications at the rate of 1 pound to 100 gallons of water (1 quart per square foot of bed).

The studies show that 132 grams of chemical (Z-78, Fermate, Thiosan, Phygon XL, or Copper 8-Quinolinolate) to 819 cubic inches of soil (122 pounds to a bed 100 feet by 4 feet by 6 inches) produced a disease-free stand of seedlings of cucumber, tomato, vegetable peas, and sweet peas; otherwise the seedlings were usually badly stunted and abnormal. A fair degree of tolerance was exhibited by vegetable peas to Fermate, Thiosan, and Copper 8-Quinolinolate; by sweet peas to Z-78, Phygon XL, and Copper 8-Quinolinolate; and by cucumber to Phygon XL.

Up to now the studies have not shown that chemical soil treatments applied at periodic intervals since February when beds were planted to carnations are any more effective than water or no treatment. Some of these treatments have not controlled Rhizoctonia stem rot.

All of the fungicides considered were effective disinfestants when used to douse carnation cuttings, but only the mercury chemical (Puratized Agricultural Spray) was both fungicidal and bactericidal. Immersion of cuttings for 15 minutes in one fourth teaspoonful of this chemical to 1 gallon of water with wetting agent shows promise.

**Investigation of Fungicides Which Promise Value in Apple Disease Control.** (E. F. Guba, Waltham.) With the cooperation of Dr. Ernest E. Lockhart, Department of Food Technology, Massachusetts Institute of Technology, the residual mercury on apples from trees sprayed with Puratized Agricultural Spray (5 percent phenyl mercuri triethanol ammonium lactate) 1 pint to 100 gallons of water was determined. Apples from trees sprayed up to one month before harvest, or ten times, retained only about 5 parts of mercury per 100 million parts of fruit; apples from trees sprayed up to the middle of July, or eight times, showed mercury values essentially identical with those of apples from trees not sprayed with mercury. Whether the very small quantity of mercury retained by apples sprayed after the middle of July is of any consequence remains to be decided by Federal agencies, and no immediate decision from these sources is anticipated.

Foliage chlorosis from Phygon was prevented fairly well on Baldwin and Delicious by the addition of Epsom salt in a ratio of 1:1, but only partial correction was noted on McIntosh. The addition of Epsom salt caused a serious russeting of Delicious apples, but not of Baldwin. Insecticide alone (lead arsenate and DDT) seriously russeted Baldwin apples, but not Delicious.

Microtome sections of apple leaves from trees sprayed with phenyl mercuri monoethanol ammonium acetate (Puratized Apple Spray) and phenyl mercuri acetate (Tag 331) show the eradicant action of these solutions on manifest and

incubating foliage scab. In a comparison of six fungicides in a belated schedule of two and three applications beginning June 2 after scab was manifest, the phenyl mercuri acetates gave the best control of fruit scab and some disinfection of fruit infection.

**Miscellaneous Studies.** (E. F. Guba, Waltham.)

*Investigation of Chlorosis of Apples Caused by Phygon and Search for a Corrective.* (In cooperation with the United States Rubber Company.) Chlorosis was successfully produced on bean foliage in the greenhouse. Prevention or correction of chlorosis on beans was accomplished by the addition of Epsom salt, manganese sulfate, or magnesium phosphate in a ratio of ¾ pound of chemical to 1 pound of Phygon. The differences in the results with these chemicals were narrow, but Epsom salt furnished excellent correction.

The use of Epsom salt for Phygon chlorosis on apple trees would seem appropriate, since it is widely used in the apple industry to prevent magnesium deficiency. In orchard tests chlorosis was prevented fairly well on Baldwin and Delicious by combining Phygon with Epsom salt in the ratio of 1:1. Partial correction was noted on McIntosh.

The manufacturer, in recognition of these and similar results, has combined Phygon with Epsom salt in the ratio of 1:1 in its product Phygon XL, and has recommended the addition of ½ pound of Epsom salt to each pound of Phygon XL in the spray tank. Phygon chlorosis was absent up to July 1, 1949, on Delicious; quite noticeable on Baldwin; and hardly noticeable on McIntosh foliage following four applications of Phygon XL and Epsom salt from April 22 to May 25. Delicious apples were russeted by this combination of chemicals. Foliage chlorosis was confined to the leaves present at the time of the orchard treatments.

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## DEPARTMENT OF CHEMISTRY
### Walter S. Ritchie in Charge

**Factors Affecting the Vitamin Content of Milk and Milk Products.** (Arthur D. Holmes.

*Composition of Percheron Mare's Colostrum.* (Arthur D. Holmes, Albert F Spelman, and Robert F. Wetherbee.) The colostrum was obtained from four purebred Percheron mares maintained on the University farm for classroom instruction and draft purposes. The mares weighed from 1600 to 1900 pounds, were 4 to 11 years old, and were in the first to sixth lactation period. Thirty samples were collected for the first six days of lactation.

The average water content of the colostrum was very similar for the different mares. The protein value of the colostrum varied considerably, but was higher than that of milk produced by mares in later stages of lactation. The amount of reduced ascorbic acid in the colostrum was small compared with that found in mature milk. Initial samples of colostrum contained less phosphorus than later samples, but the colostrum contained more phosphorus than mature milk. Also the average amounts of potassium and magnesium were higher than in mature milk. The values obtained for colostrum during two lactation periods of the same mare were in close agreement.

*Loss of Reduced Ascorbic Acid from Lactose-Enriched Milk.* (Arthur D. Holmes.) In earlier studies the rate of loss of reduced ascorbic acid from mare's milk was found to be only a fraction of the rate of loss from cows' milk when both were stored in commercial glass milk bottles in the dark at 10° C. Since mares' milk contains much more lactose than cows' milk, it seemed desirable to

determine whether the addition of lactose to cows' milk would decrease the rate of loss of reduced ascorbic acid from cows' milk to that observed for mares' milk. Accordingly, on each of fifteen weeks between April and August, three samples of milk were prepared and assayed for reduced ascorbic acid daily for a five-day experimental period. To one sample, 15 grams per liter of analytical reagent grade *alpha*-lactose was added; and to a second sample, 30 grams per liter; while the third sample served as a control. There was no significant difference in the rate of loss of reduced ascorbic acid in the three series of 15 samples each, during storage in darkness for 96 hours at 10° C. From these results it was concluded that even though the lactose in mares' milk might not be in the same form as that added to the cows' milk, the high lactose content of mares' milk is not the principal factor in causing the greater stability of reduced ascorbic acid in mares' milk than in cows' milk.

**Changes in Vitamin Content Coincident with Different Stages and Rates of Maturity of Vegetables Used for Home Consumption.** (Arthur D. Holmes.)

*Some Results of Hormone Treatment of Field-Grown Tomatoes.* (Arthur D. Holmes, C. Tyson Smith, John W. Kuzmeski, and William H. Lachman.) The 1947 annual report discussed the food value of hormone-treated tomatoes which had been grown under greenhouse conditions during winter months. During the past year, the study was continued with hormone-treated tomatoes grown during summer months under outdoor conditions. Standardized Pritchard, Harris strain tomato seed was sowed April 10 in flats in the greenhouse, and the resulting well-developed plants were set out in an unshaded field on May 28. The plants were staked, pruned of all side branches, and fertilized with a 5-8-7 commercial fertilizer applied broadcast at the rate of 2000 pounds per acre. The tomato plants were divided into three groups: (a) hormone-treated plants, (b) emasculated and hormone-treated plants, and (c) controls. There were three replicates of each, or a total of twelve groups of tomato plants. The hormone was B-naphthoxyacetic acid applied with a nasal atomizer at a dilution of 50 parts per million. The applications were made directly into the individual flowers from time to time as fast as blossoms opened. Records were made of meteorological conditions during the growing period of 89 days; namely, hours of bright sunshine, inches of rainfall, relative humidity, and temperature changes. Analyses of representative samples showed that the three groups of tomatoes contained similar amounts of water, total solids, ascorbic acid, calcium, and magnesium. The controls contained the most potassium. The emasculated and hormone-treated tomatoes contained the least manganese but the most carotene, nitrogen, and phosphorus. However, judged by the results, the nutritive value of the hormone-treated tomatoes was not enough superior to that of the controls to justify their production.

*Influence of Light During Storage on Composition of Blue Hubbard Squash.* (Arthur D. Holmes, Albert F. Spelman, Charles J. Rogers, and William H. Lachman.) In this area, squashes may be stored during winter months in the dark in especially constructed storage houses, or, in some instances, in greenhouses fully exposed to bright daylight. Since Blue Hubbard squash is extensively grown in this area, and is typical of the hard-shelled varieties, it was chosen for a study of the possible influence of light during winter storage on the composition of squashes. The squashes were stored in a dry, well-ventilated laboratory attic, one-half in darkness and the others exposed to a known amount of illumination 24 hours per day for the experimental period. Typical squashes were assayed for water, carotene, ascorbic acid, reducing sugars, and total sugars at the

beginning of the experimental period and after 28, 60, and 102 days of storage. The composition of individual squashes varied, but there was no consistent difference in the composition of the squashes stored in the light and those stored in the dark. However, the amount of carotene, ascorbic acid, and reducing and total sugars found in the squashes at the end of the long winter storage showed that Blue Hubbard squashes stored either in the light or in darkness are a valuable source of constituents of the human diet.

*Storage Losses of Butternut Squashes.* (Arthur D. Holmes.) Butternut squashes, even though developed rather recently, have met with popular favor and are being grown in constantly increasing numbers in this area. They have high food value and are particularly rich in carotene, but they are generally poor keepers. Therefore, it seemed worth while to study storage losses of this variety of squashes under controlled conditions. Two comparable lots of Butternut squashes were stored in a dry, well-ventilated laboratory attic, separated only by a half-inch movable partition; but one lot was continually in darkness while the other was exposed to constant, controlled illumination. At the beginning of the nine weeks' experimental period, the squashes in the two lots averaged to weigh 1191 and 1193 grams. The loss in weight of the squashes stored in darkness was 20.3 percent, and for those stored in constant light, 15.8 percent. The loss of squashes through decay was 69.9 percent for those stored in darkness and 77.9 percent for those stored in the light. The decay was judged to be largely if not wholly due to black rot (*Mycosphaerella citrullina*). From the results of this preliminary study, it appears that exposure of squashes to continuous light during winter storage may influence the rate of spoilage by black rot.

**Yield and Composition of Ladino Clover as Influenced by the Quantity and Ratio of Potassium, Calcium, and Magnesium in the Soil.** (Mack Drake.) Ladino clover was grown in greenhouse pots on a Merrimac fine sandy loam soil, low in base exchange capacity (3.5 m.e. milli-equivalents per 100 grams of soil) and low in exchangeable bases. Calcium and magnesium, supplied at several different rates in exchangeable form as bentonites and also as dolomitic limestone, were combined with potassium supplied as potassium bentonite and as potassium chloride. Adequate amounts of nitrogen, phosphorus, sulfur, and boron were supplied to all treatments.

The check treatment yielded 1¾ tons, while the highest yield of over 4½ tons of oven-dry hay per acre was produced in three cuttings by increasing the exchangeable bases as follows: calcium from 1.5 to 8.0 m.e.; magnesium from 0.12 to 4.0 m.e.; and potassium from 0.125 to 0.5 m.e. The calcium and magnesium content of the hay from this highest-yielding treatment was at a desirable level in the first cutting but decreased about one-half in the second cutting.

The combination of potassium bentonite and two tons of dolomitic limestone produced 4 tons of hay; and 3 2/3 tons were produced by the use of three tons of dolomitic limestone with 120 pounds of $K_2O$ initially and after each cutting.

The calcium and magnesium content of hay was higher and potassium was lower when the calcium and magnesium were supplied as dolomitic limestone than when supplied as bentonites. Also, the decrease in the percentage of calcium and magnesium in the second-cutting hay was considerably less when dolomitic limestone was used. Thus it appears that for highest yields and highest content of calcium and magnesium, these elements should be supplied both by the base exchange complex of the soil and as dolomitic limestone.

**The Nutrition of Apple Trees.** (Mack Drake, in cooperation with Pomology and Agronomy Departments.) Chemical composition of apple leaves and trunk

diameters of trees were used as a basis for pairing trees which constitute plots in laying out a mulch-fertility experiment with 15-year-old McIntosh apple trees. Chemical analyses were made of field-baled grass hay to be used for mulching. Variation in composition was reduced about one-half by breaking the bales, thoroughly mixing, and rebaling. Further information on this project may be found in the report of the Pomology Department.

**Yield and Composition of Forage Crops.** (Mack Drake and William G. Colby.) In a study of the relative abilities of forage grasses to grow on soil low in available potassium, eleven common forage grasses were grown from January to June in greenhouse pots on a Merrimac fine sandy loam soil. This soil was low in available potassium, containing only 0.125 milli-equivalents of exchangeable potassium per 100 grams of soil (120 pounds exchangeable $K_2O$ per acre). Adequate amounts of nitrogen, phosphorus, calcium, magnesium, and sulfur were supplied.

Kentucky blue grass produced the highest yield, 8.2 grams (oven dry). Using this value as 100, the relative yields were: timothy, 91; Reed's canary grass, 88; commercial orchard grass, 81; perennial rye grass, 76; red top, 71; late-maturing orchard grass, 70; tall fescue, 68; tall meadow oat grass, 67; meadow fescue, 66; and smooth brome grass, 47.

The potassium content of Kentucky blue grass was very low, 0.246 percent, while the smooth brome grass, which produced less than half as much dry matter, contained 0.41 percent potassium. All of the grasses except red top contained a lower percentage of potassium than smooth brome grass. Late-maturing orchard grass yielded less dry matter but contained one-tenth more potassium than commercial orchard grass, indicating a greater potassium requirement for the late-maturing type.

Large amounts of available potassium are required by the legumes, Ladino clover and alfalfa, since over 200 pounds of $K_2O$ per acre may be removed annually by these crops. When the supply of available potassium is not maintained, grasses "crowd out," or replace, the clovers. Since Kentucky blue grass, timothy, orchard grass, red top, and Reed's canary grass produced considerably greater growth than smooth brome grass when grown on a soil low in available potassium, this may help to explain why these grasses usually crowd out alfalfa or Ladino clover and why smooth brome grass has shown a lesser tendency to crowd out these legumes.

**The Investigation of Agricultural Waste Products. 1. The Chemical Investigation of Lignin.** (Emmett Bennett.) Polarigraphic analysis applied to certain organic compounds with ring structures has been helpful. Comparative polarigraphy of lignin was abandoned after obtaining the polarigraph of pure unmodified lignin.

Investigations have been conducted to determine by methylation procedures whether or not hydroxyl groups are involved in the simultaneous oxidation and nitrogen fixation reaction. Complete methylation essentially prevented the fixation of nitrogen. Previous oxidation and fixation treatments did not alter the compound enough to prevent a considerable degree of methylation. These results are interpreted as indicating that the phenolic hydroxyl groups were destroyed during oxidation and that the increase in percentage of methoxyl effected by methylating the oxidized product was due to the presence of alcoholic, not phenolic, groups. Therefore, the fixation of ammonia took place by way of the phenolic hydroxyl groups. Details of this investigation may be found in "Soil Science."

**Studies on The Quantitative Estimation of Hemicelluloses.** (Emmett Bennett.) The determination of hemicellulose, as published in Analytical Chemistry 20: 642, 1948, is dependent upon rather strict adherence to a standardized procedure. This involves an estimation of the extent to which lignin has been removed and a subsequent separation of holocellulose by filtration, which may result in the loss of hemicelluloses which have become somewhat solubilized. Attempts are being made to eliminate these losses and, at the same time, to cut the time of operation by producing the holocellulose and performing the rapid extraction of hemicelluloses with sodium hydroxide, all without filtration. Preliminary trials, employing techniques cited in the above publication, indicate that a separation of lignin, freed by sodium chlorite, may be removed from the final solution prior to oxidation with chromic acid. Since separations are eliminated until the end, the action of sodium chlorite must be stopped before the introduction of the alkali. Subsequent color changes in the final solution as a function of the chlorite must also be eliminated or made constant so that the spectrophotometric measurement of reduced chromate will be a true function of the quantity of hemicelluloses which have been oxidized. These details are now receiving attention. Preliminary trials indicate that a successful integration may be possible.

**Chemical Investigations of Hemicelluloses.** (Emmett Bennett.) Quantitative estimations of xylose in hemicellulose fractions from corn stalks have been successful. Xylose, usually the main constituent in polyuronide hemicellulose, is not readily determined as such but must be arrived at indirectly; hence, the adaptation of a method suitable for the major constituent is helpful. The procedure involves the formation of dibenzylidene dimethyl acetal of xylose, a white, felt-like, crystalline material which can be readily filtered and measured. Most other sugars do not react with the reagents used in this procedure. Accordingly, quantitative measurements have been made of xylose in the hydrolysates of hemicellulosic fractions.

Periodate oxidation of hemicelluloses has been studied in order to make chain length measurements of the different hemicelluloses. This reagent will react with the terminal and/or reducing groups and main chain residues connected through a 1-6 type of linkage. A consideration of these facts in the final calculations yields values which indicate that the chain length of hemicelluloses in corn stalks may range from about 10 to 30 anhydrous monosaccharide units of an average molecular weight of about 136 . These values agree well with data obtained from different materials by other methods. They are yet to be compared with a measurement of different methyl derivatives. In the absence of such data, the evidence at hand seems to indicate that the 1-6 type of linkage in the polymers is nearly absent, and that linkages in the pentose units are probably of the 1-4 variety.

In general, the consumption of periodate in the oxidation of polysaccharides is a function of structure. Oxidation of hemicellulosic fractions in buffered media and at low temperatures indicates that the ratio of moles of periodate consumed to moles of carbohydrate oxidized was 1:1 in the chains of greater length and of firmer attachments; the shorter and more soluble chains utilized a lesser amount of periodate per mole of carbohydrate.

**Dental Caries.** (Julia O. Holmes.) This study, initiated in 1944, had as its ultimate goal the finding of methods of reducing or preventing tooth decay in man, particularly in the New England area where the condition exists in a rampant form. The study was based on the premise that susceptibility to dental

caries is determined by the diet, that some of the foods commonly eaten by man may contain an anticariogenic (tooth decay-preventing) factor, and that foods could be tested for this factor by feeding them to experimental animals as supplements to the standard cariogenic diet. No food has yet been found which would protect against the rampant tooth decay induced by this diet, but some of the findings support the theory that the diet may be an important determiner of susceptibility to dental caries.

The experimental animal used in the study was the Norway rat. Earlier reports were based on an examination for cavities on the grinding surface of the twelve molar teeth. In the work reported here, the teeth were examined under a microscope for early signs of decay in the deep fissures; and in evaluating results, both incidence and extent of decay have been taken into account. The method of preparing animals for this study, unless otherwise specified, was to feed healthy mothers the same ration of natural foods that is used for the entire breeding colony. This diet is satisfactory for good growth and for fairly good reproduction and lactation. At 21 days of age the young rats were placed on the experimental rations and fed ad libitum for eleven weeks. When two or more rations were to be compared, they were fed to littermate brother or sister rats. The standard cariogenic ration is composed of highly purified foods, adequate in protein, fat, vitamins, and minerals, and containing all of its carbohydrate (73 percent of the ration) in the form of fermentable sugars, either sucrose or dextrose. This ration allows the rat to grow well, maintain good health and vigor, and in a number of experiments supported good reproduction and fairly good lactation.

*Fermentable Sugars.*—The excessive consumption of sugar has almost invariably led to marked tooth decay. Of the 200 rats fed the standard cariogenic diet, only six were completely free of tooth decay. When the sugar was completely replaced by either raw or cooked starch, the rats experienced markedly less decay. Since tooth decay has occurred to a substantial degree in rats never having received sugar, it seems fair to conclude that, although excessive consumption of sugar aggravates dental caries, it is not the only cause and may not be the fundamental cause of tooth decay in the rat.

*Maternal Diet.*—Three different maternal diets were compared for their effect on tooth decay in the young rats: the standard cariogenic diet during pregnancy, fortified with 10 percent additional protein, in place of an equal amount of sugar, during lactation; the standard cariogenic diet without the additional protein throughout pregnancy and lactation; and the regular breeders' diet of natural foods. At weaning, the young were fed the standard cariogenic diet. The young of mothers receiving the breeders' diet had much lower scores, for both incidence and extent of decay, than either of the other groups. The group whose mothers had the additional protein came next; while in the group whose mothers had the cariogenic diet without the additional protein, tooth decay progressed so rapidly that it was necessary to terminate the experiment at eight weeks instead of eleven. These results point again to the influence which the diet exerts in determining susceptibility to tooth decay.

*High Protein Diets.*—Casein, a protein of milk, when fed in large amounts markedly retarded or completely inhibited tooth decay. This effect was obtained only when casein supplied from 35 to 50 percent of the total weight of the ration or from 34 to 47 percent of the total calories.

In order to determine whether this effect on caries was due to the casein, or to the reduction in sugar content of the ration which accompanied the increase in

casein, a diet was fed in which dextrin replaced sugar in an amount equivalent to the extra casein. While tooth decay was less than on the standard cariogenic diet, the reduction was not so great as was found in littermates receiving the high-protein diet. It is, therefore, apparent that some but not all of the beneficial effect of the high-protein diet was due to decreased sugar consumption.

Several of the individual amino acids of which casein is composed were fed in amounts equivalent to that in a ration containing 50 percent casein. None of these, when fed in conjunction with the standard cariogenic diet, had any retarding or inhibiting influence on the incidence or extent of tooth decay.

Animal proteins contain a factor now know as vitamin $B_{12}$, necessary for growth of animals and for the prevention of pernicious anemia in man. A 50 percent casein ration is rich in this factor; but when it was fed in the form of liver extract or the "cow-manure factor", tooth decay was not reduced. Therefore the anti-cariogenic effect of casein-rich rations cannot be explained on the basis of the content of the "animal protein factor."

Casein which was digested by enzymes to a form in which the amino acids are freed from combination with each other and which was probably freer of contamination with other substances than was the undigested casein, was fed at a level of 50 percent. It was as effective as the undigested casein in inhibiting tooth decay.

*Urea.*—Crystalline urea, either fed in the drinking water or mixed in the standard cariogenic diet at levels of 1.5, 2.0, or 2.5 percent, partially inhibited tooth decay, but 0.3 percent had no retarding effect. These findings were obtained with rations containing small (14 percent) to generous (26 percent) quantities of casein. In an attempt to increase the body's output of urea (the end-product of amino acid metabolism) without introducing it into the oral cavity and thereby providing a potential alkaline reaction in the mouth, the amino acid arginine was fed alone and also with glutamic acid and glycine, in conjunction with the standard cariogenic diet. Although arginine not only gives rise to more urea than does any other one amino acid but also is concerned in the body's manufacture of urea, no retardation of tooth decay was observed.

*Crystalline Methionine.*—Methionine, a sulfur-containing amino acid, when fed in the crystalline form under certain conditions aggravated tooth decay. Its deleterious effect was greater when fed with a low (10 percent) protein ration than with a 15 percent protein ration. When added to a ration in which dextrin replaced all the sugar, it made the dextrin ration as cariogenic as the standard cariogenic ration. This latter finding of marked caries in rats fed sugar-free diets gives additional evidence that excessive consumption of sugar is probably not the fundamental cause of tooth decay. When methionine was fed along with all the other amino acids in the form of predigested casein, no deleterious effects were observed. This suggests that an amino acid imbalance may predispose to dental caries.

*Heredity.*—Three distinct strains of rats have been studied. The young rats from the three strains grew equally well when placed on the stock colony diet and presumably were in good health. These strains also grew equally well on the standard cariogenic diet, but showed marked differences in their susceptibility to tooth decay. Inasmuch as similar strain differences in susceptibility to decay have been reported by the Wisconsin investigators for a different species of animal, the combined findings suggest that in man, too, heredity may determine susceptibility to tooth decay.

*Glutamic Acid.*—Although glutamic acid neither accelerated nor retarded tooth decay, it did aid in the disintegration of the teeth, presumably by dissolution. The eroding effect appeared to be confined to the dentin and resulted in a deep cupping of the grinding surface, with the enamel walls of the tooth unaffected. This type of erosion appeared to be distinctly dissimilar to that found in rats fed cola-type beverages, acid fruit drinks, or solutions of sugar and acetic or citric acids, all of which dissolve both enamel and dentin on the tongue side of the tooth. The feeding of glycine and arginine together with glutamic acid did not nullify the dentin-dissolving effect of glutamic acid; but when all the amino acids were fed in the form of predigested casein, glutamic acid did not exert its eroding effect.

(The Office of Naval Research, Department of the Navy, reimbursed the University of Massachusetts for the major portion of the expense of these studies. A grant-in-aid from the National Dairy Council, Chicago, is also acknowledged.)

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## THE CRANBERRY STATION
### East Wareham, Massachusetts
### H. J. Franklin in Charge

**General.** Severe drouth with high temperatures and an excess of sunshine in August curtailed the 1948 cranberry crop considerably, it being estimated that 5 percent of the fruit in Massachusetts and 10 percent of that in New Jersey was ruined by baking on the vines. In spite of this, Massachusetts produced 605,000 barrels, easily a record.

The Early Black fruit proved to have superb keeping quality. The Howes variety was only fair in this respect, due apparently to high November temperatures. A general forecast of the keeping quality was made by the Station in mid-June, and this seemed to be successful enough to justify further attempts of this kind in the years to come.[1]

**Injurious and Beneficial Insects Affecting the Cranberry.** (H. J. Franklin.) The third and fourth parts of the work on cranberry insects—dealing with the pests attacking the stems and roots—were completed. The insect and disease control chart was revised and brought up to date as usual.

In cooperation with the A. D. Makepeace Company, of Wareham, and the Farm Supply Service of the Eastern States Farmers' Exchange, of West Springfield, the Station made some study of DDT residues remaining on cranberries at picking time after summer treatments for fruitworm control. Residues of about two parts per million were found on fruit from areas sprayed with 3 pounds of 50 percent wettable DDT in 100 gallons of water, 400 gallons per acre, on July 22 and picked on August 22, 1948. The weather was generally very dry and sunny from the time the spray was applied until the berries were picked. The results of this study suggested that DDT should not be used on Massachusetts cranberry bogs later than mid-July. There seldom should be real occasion for such a late application anyway.

*Prevalence of Cranberry Insects in the Season of 1948:*

1. Fireworms were rather less abundant than usual during this season but, as usual, had to be treated on some bogs.

2. The cranberry fruit worm was about normal in abundance, but spotty—some bogs having none of the eggs and others a considerable number, as many as 89 eggs to 100 berries having been found on a bog at Hyannis.

[1]Mass. Agr. Expt. Sta. Bul. 450. 2. 1948.

3. The false armyworm was possibly more abundant than normal.

4. There was a widespread abundance of the cranberry weevil. This insect gave more general trouble than in any previous year in the writer's experience.

5. The cranberry spittle insect was widely harmful in Barnstable County, being more definitely troublesome there than in most years.

6. Mites were prevalent on a few bogs but were largely controlled by heavy rains.

7. Both hive bees and bumblebees were extremely abundant on the bogs throughout the cranberry flowering period everywhere.

8. The gypsy moth on the whole was about normal in abundance, being quite destructive in some sections but not giving much trouble in others. It was generally controlled very well on the cranberry bogs and their surroundings by the use of DDT.

9. No fire beetles were reported anywhere, and spanworms seemed less troublesome than usual.

10. The fall armyworm appeared in damaging numbers on a bog of the Smith-Hammond Company, in Carver, following removal of a grub flood on July 15. This is the first recorded appearance of this insect on a cranberry bog in Massachusetts. The worms were first discovered on August 3. Many of them were then an inch long.

The fall armyworm also appeared in damaging numbers on a bog of H. F. Whiting, at Plympton, following removal of a grub flood. This species also appeared in large numbers on the Ware Bog of the John J. Beaton Company, in Plymouth, after removal of a grub flood, being associated in this case with rather larger numbers of the black cutworm. The fall armyworm and the black cutworm appeared together in abundance on the Decas Bog, at Mary's Pond in Rochester, following a grub reflow.

11. The cranberry girdler was notably less troublesome than usual.

**Frost Forecasts.** (H. J. Franklin.) Afternoon and evening forecasting of frosts for the cranberry bogs was sponsored by the Cape Cod Cranberry Growers' Association and continued as in previous years, there being 213 subscribers to the special telephone service in the seasons of both 1948 and 1949.

**Control of Cranberry Bog Weeds.** (C. E. Cross.) Over 200 experimental areas were treated and later studied for effectiveness of weed kill and possible injury to cranberry vines. In addition, nearly 100 commercial scale operations were to some extent supervised and the results studied. The following materials were used in varied concentrations and at varied rates of application: Sodium salt of 2,4-D, tri-butyl ester of 2,4-D, iso-propyl ester of 2,4-D, Stoddard Solvent (the product of five different refineries), kerosene, ferrous sulfate (both dry and in solution), sodium chloride (concentrated solutions only), and ammonium thiocyanate. A comprehensive study was made of the relation of various weather conditions to the effectiveness and selectivity of kerosene and Stoddard Solvent treatments in spring and summer.

During this last year, Stoddard Solvent has proved a cheaper and more effective killer of some bog weeds than kerosene. If it is sprayed as a fine mist on young grasses, sedges, rushes, and sand spurrey in April, it can be 100 percent effective, at 200 gallons per acre, and during this month causes no observable injury to cranberry vines on new or old bogs. It is most effective when sprayed under conditions of high humidity when the oil is slow to evaporate. Heavier dosages up to 400 gallons per acre are necessary to kill established tussocks of spike rush and wool grass. Asters are not easily controlled with Stoddard Solvent

until they are 6 to 8 inches high; but, since they are 10 to 12 inches high (on "early-drawn" bogs) by the time cranberry vines begin their seasonal growth, they can still be selectively controlled late in April or early in May by Stoddard Solvent sprays. Very heavy applications of Stoddard Solvent, 600-800 gallons per acre applied in late April, have given over 90 percent control of the small bramble. This is the first chemical treatment ever found that would control this *Rubus* selectively in cranberry bogs. Cranberry growers can use Stoddard Solvent safely late in May or early in June only during the first five days after the drawing of a late holding of the winter flood. Under these conditions, a mist spray of 300 gallons per acre gives effective control of loosestrife, a weed that appears more than normally abundant this year.

Weather and spraying studies have shown that both Stoddard Solvent and kerosene sprays are effective on moist or wet bogs, provided there is no standing water on the bog surface. Windy days, when the humidity of the air is low, are the best on which to spray kerosene late in the season. Some kerosene sprays applied in September and October, 1948, caused no cranberry vine injury, indicating that the fall treatment of bog weeds should receive further study.

The sodium salt of 2,4-D was the only member of the growth regulators tested that could be used safely on or adjacent to cranberry vines. It was further found that only the most concentrated solutions gave satisfactory control of loosestrife and then only before this weed had flowered. Late-season treatments with saturated solutions only contorted loosestrife plants temporarily and failed utterly in permanent control.

Esters of 2,4-D sprayed on shores of cranberry bogs as a form of chemical mowing injured cranberry vines to a distance of 30 feet, even though spraying was done with an on-shore wind which carried any drift away from the bog.

Concentrated solutions of sodium chloride (2 pounds per gallon of water) if sprayed lightly strip all the foliage from fireweeds and pitchforks without injuring cranberry vines even during the blooming period. Since these two annual weeds make a very rank growth and spread rapidly by means of their highly viable seed, it is advisable that growers use the above spray as soon as either of these weeds becomes noticeable on the bog.

Solutions of ferrous sulfate (1 pound per gallon of water) sprayed on pitchforks in the cotyledonary stage (but not later) proved highly effective and selective in killing this weed among cranberry vines.

**Winterkilling Studies.** (C. E. Cross.) Experiments with burlap covers to prevent winterkilling were set out again during the winter of 1948-49. Because of the mild weather all winter, no killing occurred even on unprotected cranberry vines. Leaf samples were regularly collected all winter and the cell sap of the leaves examined for its index of refraction. The sugar content of the sap from leaves covered with burlap was regularly, but only slightly, lower than from fully exposed foliage.

A rather extensive series of experiments was laid out and the cranberry vines sprayed with Dowax to determine the efficiency of this material in preventing winterkilling by reducing transpiration losses. The wax applied in November, 1948, had not been washed off by rains in June, 1949. Since winterkilling conditions did not materialize, it is not known whether or not this wax would have prevented injury to the cranberry vines. Routine sampling and testing of the leaves showed a slight but consistent lowering of the sugar content in wax-sprayed foliage, indicating at least some impairment of the normal physiology of the vines. A further significant observation was made in the spring of 1949. Frost injured all the cranberry vines in the bog containing the wax spray experi-

ments, but only the areas sprayed with wax were injured severely enough to deprive the vines of a crop prospect. It is concluded, therefore, that the wax spray either stimulated a premature growth in the spring or that it somehow sensitized the vines slightly to frost. The difference in sensitivity to frost between waxed and unwaxed vines was estimated as 2° F.

Some tests with wax are being set out this summer to determine the value of such a technique in preventing desiccation during drouth periods.

**Soil Water Studies.** (F. B. Chandler.) Studies of soil water indicate that the vines dry out in some bogs with a fairly high water table; while in other bogs with a much lower water table, there is no evidence of injury. A new manometer liquid has been used in tensiometers, and new cups have been designed.

**Fertilizer Requirements of Cranberry Plants.** (F. B. Chandler and William G. Colby.) Fertilizers with a 1–2–1 ratio produced greater yields of cranberries, and the vines had better color than where a 1–1–1 ratio was used. Applications of nitrogen at the rate of 80 pounds per acre annually are too great, regardless of the ratio of other elements. For some bogs and for the McFarlin variety, 40 pounds per acre annually is too great. Urea-form (a new nitrogen fertilizer) appears to be a very satisfactory source of nitrogen for cranberry bogs. During the past year, a response to potassium has been observed on two bogs. In one bog, the uprights had a better color where a mixture of minor elements had been applied.

The plots previously treated are being continued, and in addition plots have been treated to study the best method of applying phosphorus. Studies are being made with liquid fertilizers applied in the water for frost flow or flash flood; also, in sprinklers and applied with the fungous sprays.

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## DEPARTMENT OF DAIRY INDUSTRY
### D. J. Hankinson in Charge

**Sanitizing Agents for Dairy Use.** (W. S. Mueller.) The following progress has been made:

1. *A Method for Evaluating the Sanitizing Efficiency of Germicides Proposed for Sanitizing Food Utensils.* (W. S. Mueller.) The method which is described in the last annual report has an end point of somewhat less than 100 percent kill. This method has been improved so that it is now possible to accurately determine 100 percent kill in testing germicidal potency of most germicides.

2. *The Effect of Certain Metallic Ions on the Germicidal Activity of Quaternary Ammonium Germicides.* (W. S. Mueller and D. B. Seeley.) Among the problems that have arisen in the use of quaternary ammonium germicides is their incompatibility with certain minerals found in water supplies, certain chemicals employed in cleaning agents, and organic matter encountered in cleaning procedures. The interference pattern of these, as well as other metallic ions, on the action of a quaternary germicide has been investigated. Valence and pH were found to be the two most important factors determining the interfering power of a cation. Monovalent, divalent, and trivalent ions had interfering powers approximately in the ratio of 1:100:10,000 respectively. When adjusted to pH 7, the cations appeared to lose their inactivating effect. Atomic weight had little or no relation to inactivating power. Five times as much quaternary was required for approximately 100 percent kill at pH 3 as at pH 10. The work up to now indicates that the metallic ions interfere by competing for the cell surface, thus blocking the cation of the germicide.

3. *New Developments in Sanitizing Teat Cups.* (W. S. Mueller and D. B. Seeley.) The results of this study were published in Hoard's Dairyman, Vol. 93, No. 21, pp. 807, 812, November 10, 1948.

**Improving the Flavor and Keeping Properties of Dairy Products.** (W. S. Mueller and E. J. Finnegan.) An apparatus called the "Stinkometer" has been used in conjunction with the Swifts Fat Stability Apparatus for investigating the spoilage of butterfat by oxidation. The correlation between peroxide values and oxidized flavor in butterfat is not close. As determined with the "Stinkometer", great differences were observed in the amount of volatile reducing substances produced from fresh and oxidized butterfat. The significance of these observed differences has not been evaluated.

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## DEPARTMENT OF ECONOMICS
### Philip L. Gamble in Charge

**Transfer of Ownership and Its Effect on Agricultural Land Utilization.** (David Rozman.) Records on transfer of ownership and changes of land utilitzation have been obtained in seven towns scattered throughout the State: Mendon and New Braintree in Worcester County; Amherst in Hampshire County; West Newbury in Essex County; Halifax in Plymouth County; Berkley in Bristol County; and Colrain in Franklin County. The record of transactions covers a period of nine years, from 1940 up to and including 1948. The collection and examination of land transfers have been completed for the entire period under investigation except for portions of 1947 and 1948 for which additional data are being gathered.

The frequency of land transfers and changes of land ownership in all seven towns for the war period and the first post-war year are in general similar to the situation reported earlier for the first three towns. The total number of transactions has shown an upward trend throughout the period, although there was a slight reversal of this movement in 1945. In the first post-war year the number of transactions in all these towns was 143, compared with 89 in 1940. The total acreage involved rose to 6,296, compared with 3,711 in the earlier year. Of the 89 transactions in 1940, 45 involved land used exclusively for agriculture at the time of transfer, either on a full-time or a part-time basis. In 13 cases the change of ownership of agricultural land involved also a change in land utilization; 3 full-time farming units were reduced to a part-time basis; and 8 farms were entirely removed from agriculture. On the other hand, in 10 cases, non-farming land was transformed into operating farming units. In the first post-war year, 1946, out of a total of 143 transactions, 81 involved land used for agricultural purposes prior to change of ownership. In 6 cases full-time farming was changed to part-time farming, and in 20 cases full-time farms were transformed to non-agricultural use. Against this, in 10 cases non-farming land was taken up for part-time farming, and in 4 transactions non-farming land was developed into operating farm units.

In comparing these two periods it appears that although a movement between agricultural and non-agricultural use of land has been significant in both cases, in the first post-war year the loss of land from agriculture was on a greater scale than formerly. While this process may not be confirmed by the analysis of data for later years, withdrawal of land from Massachusetts agriculture is still proceeding on a significant scale. On the other hand, in a number of cases additional land was purchased by farm operators to be added to their existing farm units.

This was accompanied by a considerable amount of land improvement and land reclamation carried on by farm operators with a view to bringing their farms to greater efficiency, from the standpoint of both size and better utilization of land resources. Soil conservation practices are being adopted on an increasing scale, especially on the farms which have been transferred within the last few years.

In connection with the consideration of the general trend of Massachusetts agriculture, data were gathered on agricultural production for 1948 and an agricultural program was outlined for 1949.

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## DEPARTMENT OF ENTOMOLOGY
### Charles P. Alexander in Charge

**Investigation of Materials which Promise Value in Insect Control.** (A. I. Bourne and W. D. Whitcomb.) Work in connection with the cooperative project with the Dow Chemical Company was continued in 1948, both at Amherst and at Waltham.

Dormant application of both the experimental materials D-289 and D-542 gave practically complete control of black aphis on sweet cherries, as well as the scale *Lecanium quercifex* on cultivated blueberry.

Adverse weather conditions which delayed egg deposition by pear psyllas until buds were beyond the point of safe use of D-289 neutralized tests on psylla eggs in 1948. Application was delayed until buds were so far opened that the basal protective leaves on the fruit buds were killed and some of the sepals were scorched.

Tests of parathion against red mites were made to determine its value in different applications of the season's schedule. Parathion proved very toxic to active stages of the mites but had no effect on eggs, and its period of effectiveness was quite limited. In late summer application, parathion and DN-111 showed about equal effectiveness, but from previous experience DN-111 has greater residual effect.

In 1948 it developed that there were more overwintering eggs of red mite than most growers thought, and where no dormant treatment was applied some bronzing occurred by mid-June. A considerable build-up of red mite, sufficient to cause serious bronzing, was noted in late July and early August, but the mite population decreased very rapidly thereafter.

Frequent observations showed that moderate to heavy infestations of oyster shell scale on lilacs were very successfully checked by the application of Dinitro spray in dormant application.

*Control of Red Mite.*—(W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.) At Waltham the summer infestation of European red mite varied from 12 to 25 mites per leaf on August 9. Sprays were applied on that date and the reduction of mites per leaf was determined four and eleven days after treatment.

The most effective treatments, which gave complete control after four days and prevented a significant increase of mites for eleven days, were DN-111 (Dow) 1 pound—100; Vapotone XX (Cal. Spray Chem.) 1/3 pint—100; and 25 percent parathion wettable powder (Amer. Cyanamid) 1 pound—100.

Other experimental materials which gave good control after four days but failed to prevent later infestation are: Syndeet 30 (U. S. Rubber) 1 quart—100; Dimite (Sherwin-Williams) 1 pint—100; and IN-4200 (DuPont) 1 pint—100.

None of the materials caused any foliage injury when followed by abnormally hot, dry weather.

**The Value of Control Measures to Supplement the Standard Spray Program for Apple Pests in Massachusetts.** (A. I. Bourne, in cooperation with the Departments of Pomology and Plant Pathology.) Tests were run in a block of the Experiment Station orchard containing the two varieties, McIntosh and Baldwin. A lead arsenate schedule was followed throughout the season, with a combination of Fermate ½ pound and micronized sulfur 3 pounds as the fungicide.

The standard schedule of applications recommended for apples in this State was followed, including two pre-blossom sprays, calyx, and five cover sprays. For the first time the application previously designated "Emergency A," interposed between the 2d and 3d cover sprays and timed especially for codling moth control, was incorporated in the regular State schedule and became the 3d cover, scheduled normally to be applied about June 20. Lead arsenate was used in the pink and 4th cover sprays at 3 pounds; in the calyx, 1st, 2d, and 3d cover sprays at 4 pounds; and in the 5th cover at 2 pounds per 100 gallons (for maggot control).

McIntosh at harvest showed 92 percent fruit free from insect or disease blemishes; 1 to 1½ percent scarred by curculio; 1½ to 3 percent damaged by codling moth; 2 to 3 percent damaged by apple scab; and 2 percent scarred by red bug.

In plots where parathion (at 12 ounces of 25 percent wettable powder) was applied in the pink spray, fruit showed 2.8 percent injury by red bug. When this material was in the calyx spray, the amount of damage was reduced to a trace (6 apples in 1800). Fruit from unsprayed checks in the same block showed 34 percent injury by curculio, 66 percent by codling moth, 40 percent by apple scab, and 6 percent by red bug. In the portion of the orchard where parathion was applied, no appreciable infestation of either apple aphids or leafhoppers developed during the season.

*Red Mite Control with Parathion.*—No dormant treatment was applied in this orchard. Between the pink and calyx sprays a moderate infestation of red mite developed. On May 19, between the pink and calyx sprays, examination showed that in the plot where parathion was included in the pink application, one specimen of red mite was found on 25 spur clusters. Many basal leaves showed dead and shriveled mites and a few dead aphids. No living aphids were found on these trees. In the remainder of the orchard, red mites were found at the rate of 1161 for 25 spur clusters. A few eggs were found also, and a moderate infestation of aphids had developed. Each succeeding application of parathion (calyx, 1st and 2d cover) reduced red mite to a very low level; although, in every plot except where parathion was used in the pink spray, a moderate number of eggs could be found.

Hot dry weather during the summer apparently favored mite development, and by late July foliage in parts of the orchard began to show considerable bronzing. Counts made July 22 showed 4463 mites on 50 leaves in that section where no miticide was used, and serious bronzing was present. Where parathion was applied in pink spray only, counts showed 108 mites per 50 leaves and no bronzing. Where parathion was used in the calyx spray only, 6185 mites per 50 leaves were found and the foliage was seriously bronzed. Where parathion was applied in calyx and 1st or 2d cover sprays, mite infestation was 240 per 50 leaves and no bronzing was noted.

Apparently the timing was a determining factor. Parathion in the pink spray evidently eliminated the mites after the overwintering eggs had hatched and before mites had matured and deposited eggs for later broods. Parathion showed little if any effect upon eggs, and its period of effectiveness apparently was not long enough to kill many young mites from eggs present at the time of application.

*DDT.*—In the orchard in which tests of DDT were conducted, row 5 received DDT in the pink spray; DDT 2 pounds (50 percent wettable powder) plus lead arsenate 2 pounds in the calyx, 1st, 2d, and 3d cover sprays; lead arsenate in the 4th cover; and 85-15 sulfur–lead dust in the 5th cover. Row 6 received no insecticide in the pink spray; the same schedule as row 5 thereafter. Row 7 received DDT 2 pounds plus lead arsenate 2 pounds in the calyx and 1st cover; lead arsenate thereafter. Micronized sulfur was the fungicide used (6 pounds per 100 gallons). The remainder of the orchard was given the routine schedule.

Examination of McIntosh at harvest showed that in the section of the orchard which received the standard schedule of DDT and lead arsenate in calyx and 1st cover, and lead arsenate thereafter, curculio damage ranged from 1.7 to 2.2 percent; 10 to 11 percent of the fruit showed codling moth injury (much of which was late season "sting"); and slightly more than 1 percent red bug damage. Where DDT and lead arsenate were used in calyx, 1st, 2d, and 3d covers, 89.5 percent of the fruit was free from insect blemishes. Curculio damage was held to 1.6 percent; codling moth to 7 percent (mostly late "stings"); and red bug scarred 2 to 3 percent. Fruit from the trees which received DDT in the pink and a schedule of DDT plus lead arsenate thereafter showed equally good control of curculio and codling moth, and only 1 apple in 550 examined showed scarring by red bug.

Apple scab was held to a very low figure by the wettable sulfur and Fermate combination used with the insecticides.

*Mist Blower.*—A portion of this orchard was set aside for tests of a full season's spray program with a commercial mist blower. Examination of McIntosh at harvest indicated that, in the sections where the mist blower was used, very little scab was to be found on harvested fruit (none where micronized sulfur was the fungicide, and only 6 apples in 750 on the trees receiving Fermate). Insect damage was somewhat greater than where hydraulic spraying was done. Curculio damage ranged from 6 to 7.5 percent; codling moth, 9 to 20 percent; red bug, 0.6 to 1.4 percent; and miscellaneous minor pests, 2 to 3 percent; with 70 to 82 percent of the apples free from pest blemishes.

While the degree of control of insect pests in general fell slightly below that following the conventional spraying, and in some cases was considerably inferior to that in the rest of the orchard, the results were somewhat surprising. When it is recalled that the mist blower type of machines was developed primarily for forest and roadside spraying, and that adaptations for orchard requirements are still very much in the experimental stages, the results obtained seem promising. Further adaptations to allow more flexibility in application and more accurate coverage are necessary. This was indicated by the results secured on overwintering eggs of European red mite from delayed dormant application of oil sprays by both conventional equipment and the mist blower. Counts showed 277 mites hatched on 25 bud clusters in the check row; 5 living mites following the application by power sprayer (8 cluster nozzles); and 70 mites following the application by mist blower.

**Control of Plum Curculio in Apples.** (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.) In 1948, the cool, rainy weather in May and early June concentrated curculio activity into a few critical periods when effective sprays were applied. Under these conditions, the insecticide formulations were more effective than in other seasons.

The standard formula of lead arsenate 2 pounds and 50 percent DDT wettable powder 2 pounds in 100 gallons protected 98.69 percent of the apples from damage

by the plum curculio, and justified its recommendation in the apple spray schedule. When a platelet form of lead arsenate was substituted for the regular lead arsenate in this formula, the control was even better.

Among the new materials which gave excellent control of plum curculio, in the following amounts per 100 gallons of water, are: 50 percent methoxychlor wettable powder 2 pounds plus lead arsenate 2 pounds; 50 percent chlordane wettable powder 4 pounds; 25 percent parathion wettable powder 2 pounds; and 50 percent chlordane wettable powder 2 pounds plus 50 percent DDT wettable powder 2 pounds. All of these formulas were more effective by about 10 percent than the former treatment of lead arsenate 4 pounds.

A chlorinated camphene (Toxaphene 25 percent wettable powder) at 4 pounds was slightly less effective, and caused a poor finish on the apples. Benzene hexachloride in two different formulations was the least effective even when combined with lead arsenate.

Of the new materials, methoxychlor appears to be the most practical. Parathion controls other pests equally well and has much promise if it is effective at lower concentrations. Chlordane, like benzene hexachloride, is not satisfactory for the control of codling moth in apples or oriental fruit moth in peaches.

**Apple Maggot Emergence.** (W. D. Whitcomb, Waltham.) Although fly emergence was later than the average, the survival of maggots in the soil was 58.5 percent, which is higher than in many seasons and reflects the excellent conditions for insect hibernation provided by the heavy winter snowfall.

The first fly emerged in the cages on July 4. Emergence reached 25 percent of the total on July 20; 50 percent on July 26; and 75 percent on July 31. The peak of activity was about ten days later than in recent years. The last fly emerged August 20, and flies were active in unsprayed apple trees until October 12.

**Insecticides for the Control of the European Corn Borer.** (A. I. Bourne.) Relatively cool weather during early spring retarded seasonal development considerably in late April, while continued cool and dry weather in early May still further retarded development of overwintering larvae. More frequent rains and more normal temperatures following the first week of May promoted more rapid pupation, and by May 24 approximately 50 percent of the larvae in the old stalks had pupated. There was very little evidence of winterkilling of the larvae.

Continued cool weather, especially at dusk, and frequent rains had a depressing effect on moth activity and moth emergence was slow, and a very slight amount of egg deposition was noted in the field. Since these weather conditions similarly checked the appearance and growth of corn itself, the relation between development of the insect and the corn was about normal.

Egg masses began to be noted in increasing abundance after June 20, and by June 26 evidence of hatching in the near future (black spot stage) was general. The first application of insecticides was made in test plots at Gate Hill on June 28 and was followed by applications at seven-day intervals.

Records of damage, based on tassel infestation and breakage, made previous to harvesting showed that of the sprays, DDT and parathion gave nearly perfect protection; derris and Ryanex plots showed moderate breakage; and more than 50 percent of the plants in the check plots showed infestation. Of the dusts, DDT, parathion, and Ryanex gave from 92 to 100 percent protection. Studies of stalk infestation at this time showed an average of from 2 to 2.4 borers per plant on untreated corn.

Records of the corn in the experimental plots were taken from the pickings made August 4, 5, and 6. In the plots sprayed with DDT and parathion 98-99 percent of the ears were free from any trace of injury; 91 percent of the ears in the derris plots were clean; and 96 percent of the ears in the plots sprayed with Ryania Concentrate were clean. In the dusted plots, no infested ears were found following parathion and Ryanex, and 98 percent of the crop in the DDT-dusted area was clean.

In the check plots, 81 percent of the ears showed no borer injury, indicating a rather light infestation. This was in line with conditions generally in this area and was attributed in large measure to the unfavorable weather conditions which prevented normal activity of the moths during the period of normal egg deposition. In parts of Hampden County and in southeastern Massachusetts where both growth of corn and development of the insects coincided with more normal and favorable weather conditions during the oviposition period, the infestation was much heavier and in some fields damage was extensive.

While the damage in the check plots caused by the first brood corn borer larvae, based solely on relative infestation of ears, would indicate a relatively light infestation; a comparison based on percentage of first-grade marketable corn indicates more accurately the loss caused by the insect. In the Ryanex-treated plots, 79-80 percent of the ears were of Grade 1 quality; in the derris and parathion plots, 80 percent; and following DDT, 94 percent. In the untreated check plots, only 65 percent of the harvested ears were of first grade in size and quality.

**Potato Spraying Experiments.** (A. I. Bourne.) The experimental plots were planted May 6. The field was first sprayed on June 17 when plants were 3 to 4 inches high, and 14 applications were made up to September 15. The applications after late August were for the protection of new growth from late blight, which was generally prevalent on both tomatoes and potatoes. The potatoes were dug October 14 and 15.

Flea beetles were somewhat late in appearing and were not abundant until after mid-June. A very heavy second brood appeared in late July and continued until about mid-August. Leafhoppers were never abundant in the field. Potato aphids threatened to become serious in late July and early August, but nicotine sulfate in two applications on July 28 and August 4 stopped the attack.

Observations on the seasonal abundance of flea beetles were made (by Jose Terrazas, a graduate student) at weekly intervals throughout the season, and indicated the striking effectiveness of DDT. DDT wettable powder appeared to give more lasting protection to the plants than DDT in the form of emulsion, although both seemed to kill beetles readily. The greater persistence of the dry wettable form appeared to build up an accumulative protection, and yield records reflected this difference.

The yield in the DDT (w.p.) plots was 508.13 bushels per acre, 67 bushels over that in the Bordeaux plot. In the DDT (emulsion) plots the yield was 43 bushels per acre greater than where Bordeaux alone was used. In all plots, 93 to 95 percent of the crop was of Grade 1 size and quality, and in the entire field only slightly more than 2 bushels (128 pounds) were discarded for small size or quality (imperfections, etc.).

**Control of Onion Thrips.** (A. I. Bourne.) Warm weather in early April favored early planting of onion sets and a considerable portion of the acreage in the Valley was planted to sets during the early part of that month. A reversion to cooler weather toward the middle of the month slowed down all seasonal development and not much further planting took place until the last of April and early May.

Sets were used in the test plots and were planted in late April. Growth was somewhat retarded by cold weather and frequent rains in May and continuing into June.

Thrips were rather late in appearing and developed rather slowly during June, and no infestation of any consequence developed until middle to late July. Many of the early harvested fields in the Valley showed no serious evidence of attack and very few thrips. Some "blast" developed in parts of the Valley and as a consequence some fields of sets were pulled early and onions were small. The crop in fields which escaped blast was harvested at the usual time and was of good quality.

Black Leaf 40 with pine tar soap spreader, DDT wettable powder and emulsion with Triton wetting agent gave perfect kill of thrips; Ryanex and Triton gave 90-95 percent kill. Some slight build-up in population occurred during a 7-day period following Black Leaf 40 and parathion; but chlordane and Ryanex still held thrips to a minimum, as did both types of DDT.

In dust application, DDT, parathion, chlordane, and Ryanex gave a very high immediate kill of thrips. After 7 days, DDT and parathion dusted plots showed only slight increase in population; but chlordane and Ryanex dusts had apparently lost much of their effectiveness in this time.

**Odor and Taste Contamination of Vegetables from Soil Treatment.** (W. D. Whitcomb, W. J. Garland and C. S. Hood, Waltham.) Studies of taste contamination of vegetables grown in soil treated with benzene hexachloride and chlordane were continued with plots treated in the spring and fall of 1947, and the spring of 1948.

No off-taste flavor or other detrimental effect was observed in onions, parsnips, beets, turnips, or radishes grown in this soil. Taste tests were made by the Department of Food Technology and by the Waltham Field Station on carrots and potatoes.

On boiled carrots, there was no significant off-flavor taste when the carrots were grown in soil treated with 2 or 5 pounds of chlordane, or 2 pounds of regular BHC, per acre; but soil treated with regular BHC at the rate of 5 pounds per acre produced definite taste contamination in boiled carrots.

Potatoes grown in chlordane-treated soil showed no significant off-flavor taste at the 2 pounds per acre dosage; but a slight contamination from the 5 pounds per acre treatment was detected in boiled potatoes by about one half of the tasters.

Where benzene hexachloride was used, the 5 pounds per acre dosage caused noticeable off-flavor taste in all cases, and this dosage is obviously unsatisfactory on potatoes. The 3 pounds per acre and 2 pounds per acre dosages caused noticeable contamination in some cases and not in others. Definite off-flavor taste occurred often enough to make the treatment impractical.

Applications of these insecticides in the spring just before planting caused the most off-flavor contamination in potatoes, but noticeable contamination was found where soil had been treated in the spring and fall previous to planting.

In three of four tests, heavily contaminated potatoes used as seed produced normal potatoes with negligible off-flavor taste.

With a few minor exceptions, off-flavor taste was detected more quickly and strongly in baked than in boiled potatoes.

**Control of Squash Vine Borer.** (W. D. Whitcomb, W. J. Garland, Waltham.) The natural field infestation of vine borers in sugar pumpkin, summer squash, Buttercup squash, and Blue Hubbard squash was 5.07 borers per vine. Three applications of insecticides were made at weekly intervals beginning July 12.

The best control and protection was obtained with a high setting point DDT (Vine-Safe, Sherwin-Williams Co.). A spray of 50 percent wettable powder, 2 pounds in 100 gallons of water reduced the infestation 64 percent, and a 3 percent dust 63 percent. Standard DDT as a 3 percent dust gave good protection but caused some leaf injury to the plants. Chlordane, chlorinated camphene, and a combination DDT-pyrethrum dust were less satisfactory.

**Biology and Control of the Celery Plant Bug.** (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.) The field infestation of *Lygus campestris* in the experimental planting was so light in 1948 that results from insecticide treatment were not significant. All treatments prevented injury by this pest for 30 days, and the untreated plants did not have serious damage. Dusts containing DDT regular, DDT high setting point, chlordane, parathion, and chlorinated camphene were applied and none of them caused noticeable plant injury.

Samples of specimen stalks collected 20 days after treatment were analyzed for DDT residue by the Regulatory Service of the Agricultural Experiment Station. An excessive amount of DDT was found on the leaves but a small amount on the stalks. Sprays using ½ and 1 pound of DDT in 100 gallons of water deposited a residue about equal to the informal tolerance of 7 p.p.m., while dusts left an excessive residue. These residues indicate that the methods of application must be changed, or a less toxic insecticide must be used.

**Control of Cabbage Maggot.** (W. D. Whitcomb and W. J. Garland, Waltham.) Because of continued cool weather and excessive rainfall during the active season of the cabbage maggot, the natural infestation in the untreated cabbage plants at Waltham was 45 percent, which is about 35 percent below normal. Under these conditions both 3 percent chlordane dust and benzene hexachloride dust 3 percent gamma isomer gave perfect commercial protection in one and two applications. A BHC dust containing 3 percent gamma isomer only, and one containing 3 percent gamma isomer plus other isomers were equally effective. A spray prepared with 3 pounds BHC wettable powder containing 46 percent gamma isomer in 100 gallons of water gave good commercial control but was slightly less effective than the better dusts. A 5 percent chlorinated camphene (Toxaphene) dust was the least effective of the treatments and was considered unsatisfactory. In the plots which received the most effective treatments, 90 to 98 percent of the plants produced marketable heads.

Chlordane is less likely to contaminate the soil with an objectionable residue than benzene hexachloride and is preferred where carrots, beets, or potatoes are likely to be grown in the next one or two years.

**Biology and Control of the Grape Cane Girdler.** (W. D. Whitcomb and C. S. Hood, Waltham.) Although the first activity of the grape cane girdler beetles was observed May 29-31, cool wet weather prevented further activity until June 14. Under these conditions, grape canes grew slowly with shorter nodes, and more than the usual number of grape bud clusters were cut by the beetles. Observation on 29 cut canes showed that 75 percent of them were girdled behind at least one cluster of grape buds and on 35 percent of the girdled canes two or more clusters were damaged.

Applications of insecticides to outdoor grape vines at weekly intervals reduced the number of girdled canes 90 to 95 percent. A commercial dust containing DDT, BHC, and sulfur was the most effective during clear weather but gave no protection after a rain. Lead arsenate and BHC gave good control and more protection than the dust.

In 1948, protection by insecticides was necessary from June 14 to July 3.

**Biology and Control of Common Red Spider on Greenhouse Plants.** (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.) Evaluation studies of the new organic phosphate insecticide, parathion, showed great efficiency for the material as a control for the common red spider mite on greenhouse plants.

On carnations a spray containing 2 ounces of 25 percent wettable powder in 100 gallons of water, a dilution of 1-25,600 of actual toxicant, killed 77.6 percent of the spiders. When ¼ pound was used, 90.9 percent of the spiders were killed; and the ½ pound dosage gave 97.6 percent mortality. Complete control resulted from a dosage of ¾ pound in 100 gallons, compared to a natural mortality of 14.01 percent on unsprayed plants. In a practical demonstration on benched carnations, a spray of ½ pound of 25 percent parathion wettable powder in 100 gallons of water killed 98.3 percent of the spiders three days after application, and 100 percent after five days. The natural mortality was 3.05 percent.

The ovicidal activity of parathion in this form is low, but residual action remains for at least 10 days to kill newly hatched nymphs.

**Study of Naphthalene and Similar Compounds as Greenhouse Fumigants.** (W. D. Whitcomb and W. J. Garland, Waltham.) Greenhouse fumigation with naphthalene has been replaced generally by application of organic phosphates in aerosol form, and the work on this project was done with aerosols.

On cucumbers, severe injury resulted from applications of 10 percent parathion in methyl chloride. When 10 percent acetone was added to this formula, greenhouse cucumbers were treated seven times at weekly intervals with no significant injury to the plants. One application gave complete control of the common red spider mite. It was found necessary to remove honey bees from the greenhouse for three days in order to avoid serious losses.

On carnations and roses, a 10 percent parathion-acetone aerosol killed 99 to 100 percent of the common red spider in each of eight different tests, when used at the recommended rate of 1 pound to each 50,000 cubic feet. Residual action against red spider was effective for five days after application.

In a long list of ornamental plants which were exposed, only three species of Crassula were injured.

**Study of Euonymus Scale and Its Control.** (W. D. Whitcomb and C. N. Warner, Waltham, in cooperation with the Bartlett Tree Expert Company.) Studies with the Euonymus scale were continued throughout the season.

The oviposition period of this scale extended for about a month. Eggs of the first generation were laid from June 10 to July 13, and those of the second generation from August 24 to September 20. Hatching took place in about a week and the height of crawler activity was the last week in June and again the first week in September.

On potted plants under laboratory conditions complete control was obtained with the following formulae:

Oil emulsion (Volck) 2 percent + 40 percent nicotine sulfate 1-800

Oil emulsion (Volck) 2 percent + 50 percent DDT wettable powder 2 pounds -100

Oil emulsion (Volck) 2 percent + 25 percent parathion wettable powder 1 pound–100

50 percent DDT wettable powder 2 pounds-100 + 25 percent parathion wettable powder 1 pound-100

All of these sprays were effective if applied within 10 days after the crawlers had hatched and settled. The sprays containing DDT were also effective if applied within 10 days before the crawlers hatched and crawled over the residue.

**Spraying to Prevent Twig Feeding by the Smaller European Elm Bark Beetle.** (W. B. Becker.) Several types of DDT and other new insecticides were applied by different types of spray equipment to prevent twig feeding on live elms by the smaller European elm bark beetle, *Scolytus multistriatus* Marsham. The testing method was the same as that described on pages 41-42 of the Annual Report for the Fiscal Year Ending June 30, 1947 (Bulletin 441).

1. *With Small Compressed Air Sprayers.*—All sprays used in this equipment were applied thoroughly at close range to low-growing branches of elms to obtain maximum coverage. A benzene hexachloride emulsion[1], used at 1/8, 1/4, 1/2, and 1 percent, did not give so good or so lasting protection as has been obtained with DDT emulsions of comparable strengths. When applied in the spring just after the young leaves had unfolded, serious foliage injury resulted at all concentrations.

A 1 percent Toxaphene emulsion also failed to have so lasting an effect as a 1 percent DDT emulsion[2]. A 1 percent DDT emulsion had a more lasting effect than a DDT wettable powder at a comparable concentration. The addition of soybean flour[3] or polyethylene polysulfide[4] to the 50 percent DDT wettable powder at the rate of 1 to 4 by weight seemed to prolong its effectiveness slightly, but the residue still was not so lasting as that of a DDT emulsion of comparable strength. No important spray injury resulted from mid-August applications of these materials, but none of them were effective for more than a few days when applied at the low concentrations employed against leaf-feeding insects.

Three 1 percent DDT emulsion formulations[5], developed by the United States Bureau of Entomology and Plant Quarantine for use against elm bark beetles on elm during the foliage season, and a 50 percent DDT wettable powder[6], used at the rate of 16 pounds per 100 gallons of spray, were sprayed on other species of shade and ornamental trees in mid-August to determine whether these elm bark beetle sprays would injure other trees on which the spray might fall. At the time of spraying, the air temperature was 76°F., the relative humidity 66 to 65 percent, the sky hazy, and the air calm. No spray injury was noticed on foliage the remainder of the season on white ash, purple beech, red, silver, and sugar maples, red and white oaks, or black walnut (broad-leaved trees); or on arbor vitae, eastern hemlock, European larch, or red, Scotch, and white pine (needle-bearing trees). However, formulations 1, 2, and 3 injured the foliage of Norway maple, and formulation 2 injured Norway spruce in these tests.

2. *With High-Powered Hydraulic Sprayers* (*60 gallons a minute capacity*).—Dormant applications of 2 percent DDT sprays (twice the strength of the emulsion formulations 1, 2 and 3 in the previous section, as well as one prepared with Geigy's Gesarol E 25 emulsion) gave good protection to the tops of 55 to 70 foot elms for two months. An equivalent concentration of Geigy's Gesarol Ak 50

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[1]John Powell & Company.

[2]Spraysoy.

[3]Geigy's Gesarol E 25 emulsion.

[4]Good-rite p.e.p.s.

[5]No. 1. DDT (technical) 8 pounds; xylene (industrial) 8 quarts; Triton X-100, ½ pint; water to 100 gallons.
No. 2. DDT (technical) 8 pounds; benzene (industrial) 4½ quarts; Velsicol AR-50, 2 quarts; Triton X-100, ½ pint; water to 100 gallons.
No. 3. DDT (technical) 8 pounds; Sun Solvent 1547, 8 quarts; Triton X-100, ½ pint; water to 100 gallons.

[6]Geigy's Gesarol AK 50.

wettable powder spray began to lose its effectiveness at the top of such an elm after one month. No injury resulted from any of these dormant applications.

All of the above DDT formulations were applied in early August to the same elms at one half the dormant strength, or 1 percent DDT. There was no spray injury, and all the emulsions gave good to poor protection at the top of elms after two months. The wettable powder spray gave poor protection at the tops after one month.

Protection was always better on low branches than at the tops of the elms in both dormant and foliage applications.

3. *With Mist Blowers*[7].—In dormant applications at least 4 gallons of 12 percent emulsions[8] had to be sprayed at the average elm used in these tests (55 to 70 feet high) to give good protection to the tops for two months. No spray injury resulted on dormant elms from either of the emulsion sprays, but a commercial 12.5 percent DDT-oil solution applied by the modified Buffalo Turbine mist blower caused injury and delayed growth when 4 gallons were applied per elm.

Foliage applications in early August to the same elms in the same concentration and volume resulted in protection almost equal to that of the dormant applications. Two emulsions[9] applied by the Orchardaire mist blower resulted in no foliage injury, but another[10] applied by the Accurate Tool Company mist blower did cause serious foliage injury at this heavy dosage.

**Materials and Methods Which Promise Value in Control of Insect Pests of Ornamental Shrubs, Shade and Forest Trees, and Forest Products.** (W. B. Becker.)

*Insect Control Tests*—(With Hydraulic Sprayers)—DDT wettable powders (2 pounds per 100 gallons) or DDT emulsions (1 quart per 100 gallons) apparently resulted in good prevention of injury by elm leaf miner, *Fenusa ulmi* Sund., and willow leaf beetle, *Plagiodera versicolora* Laich. Rose chafers, *Macrodactylus subspinosus* F., in a flower garden, were considerably reduced by the DDT wettable powders, but some beetle damage to blossoms still occurred, possibly by beetles which alighted on newly opened unsprayed blossoms before they contacted the sprayed foliage. Promising results were obtained against cotoneaster lace bugs and the young crawlers of oyster shell scale on lilac. No spray damage was noticed on any of the sprayed plants.

In a preliminary test in early spring, 1 gallon of a 2 percent DDT emulsion spray thoroughly wetted the outside of a 1/3 -cord pile of freshly cut red pine logs, and resulted in a material reduction of the bark and wood boring beetles which later became established in it. Comparison of sprayed and unsprayed log piles the next spring revealed 79 percent reduction of round-headed borer galleries, 86 percent reduction of ambrosia beetle galleries, 100 percent reduction of weevil galleries, and a reduction of more than half the area occupied by bark beetle galleries.

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[7] An Accurate Tool Company, a modified Buffalo Turbine, an Orchardaire, and a Stewart-Savage mist blower were used.

[8] Geigy's Gesarol E 25, diluted in water; or DDT (technical) 1 pound; Xylene 2½ pints; Triton X-100, 2 ounces; with water added to make 1 gallon of spray.

[9] DDT (technical) 1 pound; xylene 2½ pints; Triton X-100, 2 ounces; or DDT (technical) 1 pound; Sun Solvent 1547, 1 quart; Triton X-100, 1 ounce; with water added to make 1 gallon of spray, in both cases.

[10] Geigy's Gesarol E 25.

(With Mist Blowers)—In mid-August an Orchardaire mist blower was used to apply a 12 percent DDT emulsion[1] and a 12.5 percent DDT-oil solution[2] to various shade trees to combat insect pests. The quantities of spray applied were close to the small amounts commonly used to control gypsy moth larvae in roadside spraying. Good control of the imported willow leaf beetle, *Plagiodera versicolora* Laich., was obtained along roadsides, but not beyond distances of 75 to 100 feet into the woodland, even with the aid of a slight breeze. Good control of fall webworm, *Hyphantria cunea* Drury, was also obtained along roadsides. Relatively little important spray injury resulted on most plants sprayed lightly in this manner with either spray, except in instances where the blower passed too close to the foliage.

*Spray Injury Tests.*—(With Hydraulic Sprayers)—Dinitro-ortho-cyclohexylphenol[3], used in July at the rate of 1¼ pounds per 100 gallons, injured some broad-leaved deciduous plants, but no needle-bearing plants showed any injury the rest of the season. At the time of application the air temperature was 65° to 78°F., the humidity 70 to 46 percent, and the sky clear and sunny. Tetraethyl pyrophosphate[4], used at the rate of 1/3 pint per 100 gallons, and parathion[5], used at the rate of 12 ounces per 100 gallons, caused no foliage injury to any broad-leaved or needle-bearing plants tested in mid-September. At the time of the applications the air temperature was 59° to 64°F. and the humidity 57 to 51 percent, the sky was clear and sunny, and there was a slight breeze.

(With Mist Blowers)—When applied to a number of trees and shrubs somewhat more heavily than would ordinarily be necessary to control leaf-feeding insects, the 12 percent DDT emulsion described above did not cause so much spray damage to foliage as did a commercial DDT-oil solution, except in the case of sugar maple which was severely injured by both.

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## FEED AND FERTILIZER CONTROL SERVICES

### John W. Kuzmeski in Charge

The feed, fertilizer and milk testing laws are administered as one service and the operations of each, with the exception of the milk testing law, are reported in annual bulletins.

Under the milk testing law 5,016 pieces of Babcock glassware were calibrated and 233 certificates of proficiency in testing were issued. All milk depots and milk inspection laboratories in the Commonwealth were visited at least once to check apparatus and general conduct of the work.

In addition to the regulatory work the Feed and Fertilizer Control laboratories have examined feeds, fertilizers, and other agricultural materials for citizens of the Commonwealth without charge whenever the results were considered of interest to the general public or to the Control Services.

Considerable work has been done on research projects in cooperation with other departments of the University and Experiment Station. The results of such work are reported by the departments originating the projects.

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[1] DDT (technical) 1 pound; xylene (industrial) 2½ pints; Triton X-100, 2 ounces; with water added to make 1 gallon of spray.

[2] Shell's Mistoil.

[3] Dow's DN-111.

[4] Niagara's Hexide 200.

[5] American Cyanamid's Thiophos 3422.

## DEPARTMENT OF FLORICULTURE
### Clark L. Thayer in Charge

**Breeding Snapdragons for Variety Improvement and Disease Resistance.** (Harold E. White, Waltham.) Ten commercial varieties of snapdragons were crossed with Helen Tobin, a variety which was originated at the Waltham Field Station, and the resultant progeny checked for hybrid vigor and flower color. Only two crosses showed any variation in color segregation and then only a few rogues appeared. The other hybrids were uniform as to flower color and an improvement over inbred commercial varieties.

Several white hybrids were inbred and produced good color-pure progeny.

A number of inbred lines and several hybrids were tested under greenhouse conditions in West Chicago, Illinois, with one hybrid reported as outstanding in production and flower color. In December and January this particular rose colored hybrid, No. 11, produced 2.4 flower spikes.

Two strains, P4754 and Y4196, in trials with a grower in Minnesota under field conditions, proved resistant to rust disease. The grower stated that Y4196, a yellow-flowered strain, was so particularly good that he wished to try it another year.

In Lutz, Florida, the Helen Tobin variety has been grown each year since its introduction; this year the growers report that this variety will produce flowers over a longer period than any other one they grow.

A number of hybrids from George J. Ball, Inc., West Chicago, Illinois, were grown at Waltham; those particularly outstanding were Nos. 11 yellow, 12 bronze-red, 19 light pink, 23 rose color, and 34 rose color.

Tetraploid snapdragons tested were very much slower maturing than hybrids and were not so productive under conditions at Waltham.

**Sodium Selenate for Insect Pest Control on Flower Crops.** (Harold E. White, Waltham.) Selenium, in the form of a trade compound known as P-40 (superphosphate impregnated with 2 percent sodium selenate), applied at dosage rates of 3, 4½, and 6 pounds per 100 square feet of bench gave most effective control of red spider on carnations at the 4½ to 6 pound rates of application. The first application was made in August, 1948, and the next one in November, 1948.

Under normal temperature conditions when red spider infestations are light, application of sodium selenate as P-40 shows its effectiveness as a control in about 4 to 6 weeks. However, during the course of this experiment the temperature in the greenhouse was above normal late into the fall because of outside climatic conditions. Consequently the red spider population increased rapidly and the treated plants apparently had not absorbed sufficient selenium from the soil to be toxic to the great numbers of the pest. Following the initial application of P-40 in August, selenium had accumulated in the plant to as high as 100 p.p.m.; and following the second dose in November, selenium reached a concentration of approximately 200 p.p.m., which by January was adequate to keep red spider under control.

Plant analyses for selenium show that 50 p.p.m. is below the minimum for adequate spider control and under normal temperature conditions 100 p.p.m. or more will give satisfactory control.

Sodium selenate applied to the soil in a liquid form at the rate of one-fourth gram per square foot was equally as effective as the higher dosage of P-40. An explanation for this difference is that selenium in the form of P-40 applied to the surface of the soil is released slowly and unevenly by intermittent hose waterings, whereas sodium selenate in solution is carried down more rapidly to the plant roots.

Analyses and lysimeter studies of greenhouse treated soils which were later exposed to outdoor conditions for from 6 to 12 months show that in a mineralized form selenium compounds are readily leached from the soil, whereas forms of selenium intimately associated with organic matter are less readily removed from the soil by heavy leaching.

Soils treated with 6 pounds of P-40 selenate per 100 square feet, cropped for one year to carnations and then leached in the field 4 months, contained 17 p.p.m. of selenium; after 7 months, 4.3 p.p.m.; and at 11 months, 2.9 p.p.m. Samples of weeds grown on this soil contained 13 to 30 p.p.m. of selenium. In lysimeter leaching studies 12 inches of water removed all of the readily leachable selenium and added increments of water up to 60 inches did not appreciably increase the amount of selenium lost from the soil.

Analyses of a number of market garden and field soils showed the presence of 0.50 to 2.5 p.p.m. of selenium. Cabbage plants and weeds growing on these soils showed no detectable selenium in plant tissue tests.

Considerable data on analyses of soils and plant tissue were obtained in this study which will be assembled for a complete publication at a later date. This project was conducted in cooperation with the Department of Agronomy. The chemical analytic work was performed by Robert J. Allen, Jr., as partial requirement for a degree of Master of Science in Agronomy.

**Climatic and Cultural Factors Related to Carnation Diseases.** (Harold E. White, Waltham.) Air and soil temperatures in the greenhouse vitally affect growth and production of a plant crop and also determine progress of plant diseases. Temperatures ranging from 50° to 90°F. have been reported as optimum for the growth of Fusarium and Rhizoctonia fungi which cause branch rot and wilt diseases of carnations.

Weekly records of air and soil temperatures were kept from July 1948 through April 1949. Highest maximum air temperatures for the greenhouse were recorded in July, August, and September and ranged from 96° to 105°F; corresponding soil temperatures in a raised bench ranged from 65° to 72°. The mean temperatures for the same period were 74° to 76° for the greenhouse and 61° to 70° for the soil.

In this study 4274 plants were used, of which 1297 or 30 percent were lost from disease. Losses were not consistent within the same variety; many of the replicated plots showing losses as high as 40 to 50 percent, whereas in others losses were as low as 1 or 2 percent.

Losses from disease were highest in July, August, and September, the loss of plants following high temperature trends of the greenhouse and soil. Sustained high temperatures of 90°F. or above for long periods seemed to have greater influence on plant losses than extremely high fluctuating temperatures. The critical soil temperature at which plant losses from disease were greatest was 70° or above.

Difference in susceptibility of carnation varieties also has a bearing on diseases. Varieties in which plant losses were extremely high were Salmon Virginia, 82 percent; Olympic Red, 75; Mrs. C. W. Weld, 73; followed by Miller's Yellow, 51 percent; William Sim, 47; Tom Knipe, 36; King Cardinal, 35; Dark Virginia, 32; and Hercules, 30. Losses were very low in Northland and Puritan, being 1 percent or less; while Joan Marie and Virginia Rose showed no losses.

The amount of water applied to carnation plants and methods of application are frequently considered as having an effect on prevalence of stem and branch rot diseases. Plant losses from disease under four methods of applying water to the soil were as follows: copper tubing surface watering, 80 percent; Skinner pipe

system, 34; manual hose method, 81; subirrigation by manual injection, 32; subirrigation by automatic injection, 13; and constant water level, 26.

Age of soils did not appear to be related to disease losses, since soils used were 1 to 5 years old and had grown carnations for 2 or 3 years. All soils were thoroughly sterilized with steam before use.

The data indicate that soil and air temperature, method of watering, and varietal differences are associated with carnation disease losses; but there are also other undetermined factors concerned.

**The Effect of Soluble Salts on Florists' Crops.** (Harold E. White, Waltham.) This experiment was undertaken to determine the levels of soluble salts in carnation soils and to observe the effect of varying concentrations on plant growth. Soil samples were collected monthly over a period of ten months from the greenhouses of twelve commercial growers. Determinations for soluble salts were made by the Solu-Bridge instrument method, using a soil extract with a 1:2 ratio of soil and water respectively. William Sim and Tom Knipe, red-flowered varieties, were the only varieties included in the experiment.

Soluble salt concentrations, as determined by conductivity readings with the Solu-Bridge, ranged from 50 x $10^{-5}$ mhos to 270 x $10^{-5}$ mhos which correspond approximately to .25 percent and .75 percent respectively of total soluble organic and inorganic salts. There were wide fluctuations between the soils of individual growers as well as variations from month to month. Out of a total of 170 samples tested, 9 percent gave conductivity readings above 200 x $10^{-5}$ mhos, 37 percent were between 100 x $10^{-5}$ and 170 x $10^{-5}$ mhos, and 54 percent were below 100 x $10^{-5}$ mhos. A reading of 200 x $10^{-5}$ mhos, with a 1:2 soil and water ratio extract is considered the border line above which injury from soluble salts may occur. Soils having a high soluble salt content were high in total nutrient salts, particularly nitrate nitrogen and potassium.

Carnations in the twelve greenhouses showed no differences in growth that could be correlated with the existing soluble salt concentrations. Flower bleaching or burning, which commonly occurs in the spring months, was observed in several of the greenhouses, but this injury was not associated with soluble salts. From the data obtained the conclusion is drawn that carnations are tolerant of a wide range in concentration of soluble salts. However, the critical limits have not yet been determined.

**A New Carnation Disease in Massachusetts.** (Harold E. White, Waltham.) In 1948 a new disease of carnations was discovered by the writer in a greenhouse range near Waltham, and identified as carnation smut, caused by *Ustilago violaceae* (*Urocystis purpurea*). This was the first recorded occurrence of the disease in the United States, although it was recorded in Europe as early as 1926 by Hecke (Fortschr. der Landw. 1, 5, 150-151), and has also been quite destructive to carnations in England. Just how the disease got into Massachusetts is not known. The grower who had the trouble recalls having seen a few plants with the disease in 1947. Wild host plants are species of Dianthus, Cerastium, Stellaria, Lychnis, Saponaria, and Silene.

The fungus is an obligate parasite which invades stamens, the pollen grains being replaced by masses of purplish black spores. Infected plants are dwarfed and axillary shoot growth is stimulated to produce excessive weak laterals. Stem internodes are shortened; buds are short and squatty, tending to split; and ovaries are aborted. Flowers are marred by masses of purplish spores. According to Hecke, infection occurs through spores in the axils of leaves and cut flower stem stubs. Cuttings are infected by the fungus mycelium from mother plants, this being a systematic internal parasite.

The varieties of carnations found infected in Massachusetts were Salmon Virginia, Hercules, Olivette, Miller's Yellow, Northland, William Sim, Tom Knipe, and Sidney Littlefield. Little is known about modes of infection in New England and whether the fungus will winter over on host plants or as spores in the soil.

**Notes on Chrysanthemum Stunt Disease.** (Harold E. White, Waltham.) Stunt disease occurs in indoor plantings of chrysanthemums throughout the State, but severity of the disease is more or less localized. In 1948 observations as to its prevalence were made on twenty-two varieties in a near-by greenhouse. The following varieties showed varying degrees of dwarfing: Yellow Arcadia 25-90 percent; Caroline Yosick and Usonia 90 percent; Little America and Tally-Ho 75 percent; Catherine 25-30 percent; White Arcadia and Golden Jane 10 percent; December Gold, Long Island Beauty, and Yellow Daisy 5 percent. Varieties in the same planting which showed no dwarfing were Firebird, Valencia Apricot, Valencia Yellow, Masterpiece, Sunnyside, Cassandra, Sylvania, Golden Jane, Minong, Red Daisy, and Yellow Dot.

**Stunt Disease of Cyclamen.** (Harold E. White, Waltham.) A local grower experienced a heavy loss of cyclamen plants in October 1948 by a disease which was diagnosed as cyclamen stunt. This is the first record of the disease in New England, although it has been reported in the Midwestern and Western States. The fungus was isolated and found to be *Cladosporium cyclaminis*, which has been previously recorded as the causal organism of stunt disease.

Infected cyclamen plants are very slow growing, with retarded flower and bud development which results in the flowers opening near the crown of the plant and beneath the foliage. The corm and roots of the plant are attacked by the fungus, resulting in the wilting and death of the entire plant.

The source of infection appears to be contaminated soil, but the disease may also be seed-borne.

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## DEPARTMENT OF FOOD TECHNOLOGY
### C. R. Fellers in Charge

**Apple Juice.** (W. B. Esselen, Jr., M. Blauer, and C. R. Fellers.) In experimental lots of blended apple juice put up during the past season it was found that the use of apple "thinnings" and early apples for blending with mature McIntosh apples was not too satisfactory so far as the quality of the finished juice was concerned. Although the early apples and "thinnings" were higher in tannin and acid than the mature McIntosh apples they were low in solids and exerted a dilution effect on the blended juice. As has been previously observed, the blending of approximately 5 percent of crab apples with McIntosh apples was effective in improving the quality of the finished product.

**Processing Methods for Home Canned Fruits.** (W. B. Esselen, Jr., and N. Glazier.) Several varieties each of blueberries, cherries, pears, peaches, and plums were canned by recommended "cold pack" and "hot pack" methods in order to compare the effect of these two canning procedures on the quality of the product. The ultimate quality of the products was evaluated by a taste acceptance panel on a basis of flavor, texture, and color. "Cold pack" methods appeared to be preferable to "hot pack" methods for pears, peaches, and plums, while the reverse was true for blueberries. Cold and hot packed cherries were considered to be equally satisfactory.

**Heat Resistance of Home Canning Spoilage Bacteria in Soils Given Different Fertilizer Treatments.** (N. W. Desrosier and W. B. Esselen, Jr.) During 1948-49, putrefactive anaerobes were isolated from test plot soils, made available by the Agronomy Department, as follows: a. unfertilized soil, lime added; b. same as "a" with potassium added; c. same as "a" with phosphorus added; d. same as "a" with nitrogen added; e. complete NPK fertilized soil with lime added. The numbers of putrefactive anaerobes isolated from these soils were less than 100 per gram. The heat resistance of the spores isolated and cultivated was in all instances very low, less than one and a half minutes at 250 F. The phosphorus-treated soil ("c") isolates were of somewhat greater heat resistance than the isolates from the other soils. In general, the type of fertilizer employed had little influence on the heat resistance of the organism studied.

The apparent success of home canning of vegetables by the boiling-water method appears to be due to the fact that only small numbers of anaerobic spore-forming bacteria of relatively low heat resistance are present. However, similar organisms of much greater heat resistance are encountered from time to time, and pressure processing of these foods must be used to insure success in preventing spoilage and provide a safe product for consumption.

**Influence of Food Ingredients on the Heat Resistance of Spores of Putrefactive Anaerobe No. 3679.** (N. W. Desrosier and W. B. Esselen, Jr.) The ingredients of a molasses sauce and a tomato sauce used in the preparation of pork and beans were investigated. Individually, the ingredients of the molasses sauce had little effect on the heat resistance of the test spores of Putrefactive Anaerobe No. 3679 (*Clostridium sporogenes* sp.); but when these ingredients were all present, a decided increase in the resistance was observed. Evidently the individual effects were not of sufficient amplitude to be observed, or the methods employed were not sufficiently sensitive. The ingredients of the tomato sauce had comparably greater influence. The addition of vinegar and tomato juice resulted in about the same increase in hydrogen ion concentration. However, the tomato juice decreased the heat resistance more than the vinegar. The toxicity of the hydrogen ion itself does have considerable influence, but there is apparently some substance present in the juice other than the acidity which exhibits a bactericidal action against the spores. Salt in 2 percent solution decreased the resistance somewhat, and a 5 percent sugar solution increased the resistance of the spores.

**Processing Studies on Home-Canned, Low-Acid Foods.** (Cooperative Project with Bureau of Human Nutrition and Home Economics, U. S. Department of Agriculture.) (W. B. Esselen, Jr., N. W. Desrosier, D. W. Anderson, Jr., and G. Marcotte.) Pressure processing studies have been made with home canned hominy, potatoes (whole and diced), and pork and beans with a tomato and molasses sauce. These products have not been studied before.

A. *The Degree of Contamination of Foods and Its Effect on Home-Canning Process Times.*—It has often been argued that the processing requirements as described for commercially canned products are more severe than those required for similar home-canned foods. The assumption has been that in home canning a lower bacterial load is encountered in the raw products, equipment, etc. In view of this assumption, tests were set up to obtain indicative data on the effect of the degree of contamination or spore concentration on the processing times required for hominy, pork and beans, potatoes, and sweet corn. It was shown that the lethal value of home-canning process times should be at least equivalent to those used in commercial practice.

B. *Thermal Death Time Studies.*—The thermal death time characteristics of a concentration of 10,000 spores of Putrefactive Anaerobe No. 3679 per milliliter were determined in hominy, bean, and potato extracts, and were found to be 7.2, 8.2 and 7.4 minutes at 250°F., respectively. It would appear that home-canning process times to be adequate must provide this degree of sterilization for each of the above products.

C. *Heat Penetration Studies.*—The rate of heat penetration into pint and quart glass containers, and No. 2 and 2½ cans, for each of the above products was investigated. The rate of heat penetration and the thermal resistance of the test organism were correlated, and process times were derived.

D. *Inoculated Packs.*—The theoretical process times were checked by means of experimentally prepared packs, and the process times were found to be in good agreement with the above values.

**An Inhibitory Substance Present in Green Beans and the Growth of Putrefactive Anaerobe No. 3679.** (N. W. Desrosier and W. B. Esselen, Jr.) Considerable difficulty has been encountered in the past in growing Putrefactive Anaerobe No. 3679 in a green-bean medium. Occasionally growth is evidenced, but in general the organism does not grow well in this medium. Attempts to recover the organism from an inoculated green-bean medium failed. The addition of starch to the medium had no effect. The isolation of the inhibitory substances has not been completed, but the presence of quercetin in the beans offers a possible explanation. It has been reported by others that the presence of this compound inhibits the production of toxin by *Clostridium botulinum* in asparagus. However, some outbreaks of botulism have been traced to asparagus. There may be varietal differences which offer a possible explanation as to the growth and non-growth of the test organism in green beans.

**Studies on the Mechanism of Heat Transfer in Glass Containers During Thermal Processing.** (W. B. Esselen, Jr., and I. S. Fagerson.) The object of this investigation has been to study the factors influencing heat transfer rates and temperature distribution in commercial glass containers, the mechanisms of "broken-curve" heating, the significance of radiation as a mechanism in the cooling of glass containers, and the effect of container size on heating rates in glass containers.

*Time-Temperature Distribution Patterns in Commercial Jars.*—Data have been obtained for commercial 303 size jars at initial temperatures of 140° and 180°F. with 1 percent bentonite suspensions. Temperature distribution patterns were obtained by means of thermocouples located in different parts of the container.

It was noted that, in general, the rate of heating tended to be somewhat greater near the upper part of the container, probably because the rate of heat transfer was greater through the metal cap of the jar and the warmer, rising convection currents began to converge in this area.

While the slowest rate of heating was found to be in the vicinity of the generally acknowledged "cold zone", i. e., on the vertical axis and approximately three quarters of an inch from the bottom of the jar, it was often noted that comparably slow heating rates were found at a point one inch from the wall and two inches from the bottom of the jar. This observation appeared worthy of further investigation in the light of the determination of the cold point or cold zone for process-time calculations. Accordingly, the distribution and direction of convection currents were studied by introducing a dye (methylene blue) into a jar of water

and taking motion pictures of the resulting currents as the jar was heated in a constant-temperature water bath. Under the experimental conditions (initial temperature of 50°F. and water bath at 145°F.), the convection currents in 303 size jars traveled rapidly from the bottom upward along the inner surface of the container and formed a slowly descending central column within about 15 seconds after the beginning of the heating period. From 3 to 5 minutes later, the descending central column reached the bottom of the jar. During this time, currents had started from the center of the bottom of the jar and traveled upward to about 1½ inches from the bottom, the height attained progressively decreasing with time until after 5 minutes the currents were only traveling to about ¾ inch from the bottom. The velocity as well as the height attained by the rising currents next to the wall of the jar progressively decreased with time so that at the end of about 20 minutes they rose only to within an inch of the top before returning and at the end of about 27 minutes rose only to about one-half the jar height. At this time the temperature at a point ¾ inch from the bottom of the jar on the vertical axis was about 8°F. below the water bath temperature.

Similar observations made on a series of 10, 20, 30, 40, and 50 percent sucrose solutions showed the same type of distribution and direction except that the velocities of the currents appeared to be somewhat slower. From the data obtained it appears that the contents of the jars are well agitated due to natural convection, especially at the beginning of the heating period when the temperature differentials are the greatest.

*Mechanisms of "Broken-Curve" Heating.*—Heat penetration measurements were made on 10, 20, 30, 40, and 50 percent sucrose solutions in 303 size jars as a means of studying the effect of viscosity in convection heat transfer. It was noted that the 10 and 20 percent solutions exhibited simple heating curves, but the remainder all showed broken-curve heating. The data indicate a slightly slower rate of heating after the break in the curve, but not a change from convection to conduction. The above measurements were made using methylene blue so that convection currents could be followed at the same time. It was observed that the break in the curve always occurred after the convection currents had considerably decreased in velocity. This work is being continued.

**Influence of Food Ingredients on the Thermal Resistance of Bacillus Thermoacidurans.** (E. E. Anderson and W. B. Esselen, Jr.) The role of various concentrations of sugars, salt, acids, spices, and sodium benzoate, in affecting the thermal resistance of *Bacillus thermoacidurans* spores in tomato juice, was determined at three temperatures, 220°, 212°, and 204°F. From the data obtained from the rate of destruction curves, thermal death time curves were constructed. A study of these curves showed the influence of the particular food ingredient under study on the "F" and "z" values of the test organism.

Of the above-named ingredients, sucrose and dextrose, in concentrations ranging from 10 to 50 percent, were the only food materials which decidedly increased the thermal resistance of a standard spore inoculum of *B. thermoacidurans*. With both of the sugars, each increase in the concentration of the sugar increased the resistance over that in plain tomato juice. The maximum heat resistance was displayed by the 50 percent sugar solutions, which at 204°F. required from two to two and one-half times as long as plain tomato juice to destroy the test inoculum.

The addition of common salt (sodium chloride) to tomato juice, in concentrations ranging from 1 to 8 percent, caused a definite increase in the rate of destruction and therefore decrease in the destruction time of *B. thermoacidurans*.

A search of the literature revealed conflicting reports as to whether salt exhibited a protective or a lethal effect on microorganisms. Consequently, the lethal effects of increasing salt concentrations observed in the present investigation, were attributed to the increase in the hydrogen-ion concentration of the substrate. The incorporation of 2 percent salt, a concentration commonly used in brines, lowered destruction times approximately 20 percent.

The addition of citric, acetic, and lactic acids to tomato juice in concentrations of 0.5, 1.0, and 2.0 percent, proved to be a very effective means of reducing the heat resistance of *B. thermoacidurans*. Based on the percentages used, the efficiency of the acids in lowering the destruction time of the test organism was lactic, citric, and acetic; while based on the hydrogen-ion concentration, the order was: acetic, lactic, and citric.

Inasmuch as certain spices are known to exert bacteriostatic and even bactericidal action against microorganisms at room temperatures, the study of the effect of certain spices at temperatures common to the processing of acid foods was carried out. Oil of clove in concentrations of 0.01 and 0.1 percent and black pepper in concentrations of 0.1 and 1.0 percent in tomato juice resulted in increased rates of destruction and thereby decreased destruction times.

Neither sodium benzoate in a concentration of 0.1 percent nor ascorbic acid at a level of 200 mg. of ascorbic acid per pint of tomato juice caused any appreciable change in destruction times from those required by plain tomato juice.

**Effect of Allylisothiocyanate (mustard oil) and Related Compounds on the Process Requirements of Acid Foods.** (W. B. Esselen, Jr., O. Kosker, E. E. Anderson, and C. R. Fellers.) This investigation has been continued and considerable data on thermal death rate and thermal death time have been obtained to demonstrate the effect of allylisothiocyanate (mustard oil) and related compounds on the spoilage organisms encountered in acid foods. Inoculated packs of apple, grape, and tomato juices were also made to check on the validity of the data obtained. The results may be summarized as follows:

1. The thermal death times of *Aspergillus niger* in acid, sugar, and buffer solutions at different pH values were reduced approximately 50 percent at each temperature used, when 10 p.p.m. of mustard oil was added to the heating medium.

2. A reduction of approximately 50 percent in heat resistance was obtained in the thermal death time of *Saccharomyces ellipsoideus* when 10 p.p.m. of mustard oil was added to the heating medium.

3. The effect of mustard oil on the thermal death time of *Bacillus thermoacidurans* was not as pronounced as it was on mold and yeast. It would appear that this organism is not sensitive to this compound.

4. Oil of onion and oil of garlic in concentrations of 20 p.p.m. had little or no effect on the thermal death time of *B. thermoacidurans*.

5. The results obtained with inoculated packs of apple juice, using *Asp. niger* were in good agreement with the calculated process time based on the data obtained for heat penetration and thermal death time.

6. With the test organisms (mold and yeast) used, it would appear that the process times for apple and grape juices could be reduced 50 percent by the addition of 10 p.p.m. of mustard oil.

7. A concentration of 20 p.p.m. of mustard oil did not reduce the process requirements for tomato juice for *B. thermoacidurans* when determined by inoculated packs.

**Studies on the Peroxidase of Canned Acid Food Products.** (W. B. Esselen, Jr., E. A. Nebesky, and A. M. Kaplan.) A study has been made of some of the

factors affecting the thermal destruction curve of peroxidase. Calculations of the process time necessary to inactivate the peroxidase for a solid food must be based on the rate of heat penetration into the food itself. When substances that may influence enzyme inactivation such as sugar, salt, or vinegar are added to solid food products, the extent of their penetration into the food during preparation and processing must be considered. Observations were also made of experimental packs to evaluate the calculated process times. Studies were also begun to determine the effect of concentration of peroxidase on the thermal inactivation of the enzyme. A successful procedure has been developed in which a concentrated peroxidase extract could be obtained from apples.

A. *Processing Conditions of Time and Temperature.*—A study was made to determine the processing conditions of time and temperature necessary to destroy the peroxidase of canned solid food products such as whole fresh and salt pickles, peach and pear halves, apple slices, and one liquid product, apple cider.

Enzyme assays for peroxidase were carried out using a number of different substrates such as hydroquinone, guaiacol, pyrogallol, ortho-phenylenediamine, benzidine, and catechol.

In determining enzyme activity using the above-mentioned substrates with thermal destruction time studies and with processed food packs the peroxidase activity differed with the substrate. For example, studies with apple slices and apple cider using guaiacol, pyrogallol, or catechol as the substrate produced results which were identical and showed that these enzymes were of high thermal resistance in comparison with hydroquinone, benzidine, and ortho-phenylenediamine substrates. The first group of substrates showed peroxidase to be destroyed in between 20 and 25 minutes at 160°F., and between 3 and 4 minutes at 190°F.; while the second group showed peroxidase to be destroyed in between 10 and 15 minutes at 160° and between 2 and 3 minutes at 190°. Similar variations appeared among the various substrates studied with the other products concerned in this investigation. Guaiacol was considered to be the most suitable substrate to use for the enzyme assays because the thermal resistance of guaiacol peroxidase was as high as or higher than that of the other substrates mentioned, with the particular foods under study. The guaiacol substrate also produced a much more distinct difference in color which could be very easily recognized and thereby tended towards greater accuracy in the performance of the enzyme assay.

Heat penetration data were obtained for each of the different types of products used, in order to determine the accuracy of the thermal destruction data for peroxidase when applied to the derivation of processing time and temperature necessary to inactivate it. From these data calculated process times for the respective foods were determined.

Calculated process times for the various products studied were evaluated through the processing of experimental packs and showed close agreement with observed process times. Thus the possibility of closely calculating the processing conditions for the destruction of peroxidase in solid products, such as whole pickles, peach and pear halves, and apple slices, appears to be very good.

Investigations were also made to determine the amount of sugar penetration into fruit products and vinegar penetration into pickle products during preparation and processing. It was found that the addition of sugar increased the resistance of the apple and pear peroxidase to inactivation by heat. The addition of a 2.5 or 5.0 percent vinegar solution markedly decreased the resistance of the pickle peroxidase to inactivation by heat.

B. *Concentration of Peroxidase.*—Studies have also been initiated to determine the effect of concentration of peroxidase on thermal inactivation of the en-

zyme. This necessitated the development of a suitable technique for the purification and concentration of the peroxidase from the food product. It was found that if the concentration of peroxidase was increased its resistance to inactivation by heat was also increased.

**Influence of Venting Characteristics of Home Canning Jar Closures on Ascorbic Acid Retention in Home-Canned Fruits.** (W. B. Esselen, Jr., L. F. Ruder, and A. M. Kaplan.) The venting characteristics of home canning jar closures were found to have a direct relationship to the retention of ascorbic acid in products canned in such containers. That is, closures with a low venting pressure, such as those that are partially sealed, permit more headspace air to escape from the jar during processing and a greater retention of ascorbic acid in the canned product is realized. Canned apple sauce, pears, and peaches as well as ascorbic acid in buffer solutions at pH 3.5, 4.0, and 4.5 were used as the experimental media in these investigations. These findings confirm previous observations made several years ago with home-canned tomato juice.

**Changes in Volatile Reducing Substances as a Measure of Deterioration in Foods.** (W. B. Esselen, Jr., T. O'Grady, and E. E. Anderson.) The "Stinkometer", an apparatus designed by workers at the Hooper Foundation in California to measure the volatile reducing substances in fish, has been used for measuring the deterioration of other food products during storage. It appears to be of value as a means of following changes in the volatile reducing substances in packaged coffee during storage. Changes in these compounds could be correlated with the staling and development of rancidity in coffee. The method was also useful in following the development of spoilage in fresh beef during storage at different temperatures. However, it was not satisfactory for studying the deterioration of vegetable oils such as corn, cotton, and peanut oils.

**Home Freezing.** (W. B. Esselen, Jr., E. E. Anderson, N. W. Desrosier, N. Glazier, and C. R. Fellers.) During the past season 13 varieties of strawberries, 10 of blueberries, 12 of cherries, 5 of currants, 38 of peaches, 10 of pears, 20 of plums, and 28 of raspberries, provided through the cooperation of the Department of Pomology, were tested for their suitability for home freezing. The data on varieties of fruits for freezing obtained during the past four years were used in preparing a revised list of recommended varieties of fruits for freezing in Massachusetts, which is included in the revised edition of Bulletin No. 437, "Home Freezing in Massachusetts."

Further work is in progress on the use of different types of glass jars for home freezing. No evidence has been found, either in practice or from a review of the technological aspects of glass, to confirm the opinion expressed in many home-freezing bulletins, that glass is more brittle when cold.

The blueberries frozen during the past season showed a tendency to develop excessively tough skins. This condition was not encountered in previous years.

**Home Preservation of Herbs.** (W. B. Esselen, Jr.). Rapid drying at temperatures below 130°-120°F., or slow drying in an attic or in the shade were found to yield the best quality of dried herbs as measured by their volatile oil content. Dehydration at temperatures above 130°F. resulted in an excess loss of volatile oils and flavor. Blanching in steam or boiling water caused a loss of over 90 percent of the volatile oil content of herbs.

**Enzyme Systems of the Apple.** (W. B. Esselen, Jr., R. R. Reddi, and C. R. Fellers.) Some of the enzyme systems of apples have been investigated in order to obtain information which might contribute to a better understanding of the

cause and control of the discoloration which occurs in fresh and frozen sliced apples. Pectinase, protease, and esterase activity could not be demonstrated in fresh apple tissue. Studies on the enzymatic oxidation of ascorbic acid by apples showed that the presence of oxygen is essential to the reaction. The peroxidase activity of apple extracts was measured with different substrates; namely, guaiacol, ortho-phenylenediamine and pyrogallol. The method using ortho-phenylenediamine as the substrate proved to be the most sensitive for colorimetric measurements. Heat inactivation characteristics of apple peroxidase showed that whereas with partial inactivation some reactivation occurred after 20 hours, complete inactivation was not followed by the reappearance of activity during that period.

**Factors Influencing the Mold Content of Cranberries.** (W. B. Esselen, Jr., and C. R. Fellers.) Samples of so-called "sunburned" or "scalded" cranberries were found to be free of mold filaments. Samples of cranberries were obtained from bogs which had traditionally yielded fruit of good and poor keeping quality, respectively. No correlation was found between the mold content of selected "sound" samples and the general keeping quality of the fruit. Random samples of cranberries grown on different bogs and taken from storage in October showed few or no mold filaments in the sound fruit. Similar samples collected in November showed a general increase in the mold content of sound cranberries and occasional samples had a relatively high mold content. Samples of "sound" cranberries stored at 35° and 45°F., which were taken from storage the latter part of March, showed a low content of mold filaments and there was no correlation between their mold content and the temperature at which they were stored.

**Methods of Color Measurement for Controlling Color of Cranberry Cocktail and Sauce.** (W. B. Esselen, Jr.). The cranberry processing industry is frequently confronted with the problem of blending lots of cranberries of different intensities of color in order to maintain a uniform color in cranberry cocktail and sauce. A simple colorimetric method has been worked out which appears to be adaptable for canning-plant use in blending cranberries of different colors in the correct proportions to maintain a uniform color in the finished product. The Luximeter, an instrument made by the General Electric Company, was used in these tests and appears to be satisfactory for the purpose.

**Utilization of Massachusetts Fruits for Home Wine Making.** (W. B. Esselen, Jr., M. Kaplan, N. W. Desrosier, and E. E. Anderson.) During the past season experimental lots of wine were made from apples, cranberries, rum cherries, elderberries, grapes, pears, peaches, plums, and raspberries. Such variables as the use of pure yeast cultures, natural yeast, temperature of fermentation, and addition of sulfur dioxide were considered. The use of pure wine yeast inocula, addition of 100 p.p.m. of sulfur dioxide, and fermentation at a temperature of approximately 70°F. were effective in preventing the development of an undesirably high volatile acid content in homemade fruit wine. As most of the above fruits are relatively low in sugar content, additional sugar may be added to the fruit musts to raise their sugar content to 24 to 28 percent at the start. An additional 4 to 5 percent of sugar may be added during the course of the fermentation. Wines prepared by these procedures had a final alcohol content of 13 to 15 percent by volume. The finished wines were excessively acid in some cases. However, the addition of 2 to 8 percent sugar to the wine, depending upon its acidity, at the time of bottling and pasteurizing resulted in pleasing and palatable wines.

Elderberries and rum cherries were unsatisfactory when made into wine without being diluted with equal parts of water prior to fermentation. Difficulty was encountered in obtaining a complete fermentation in making cranberry wine.

**Moisture Equilibrium Studies.** (A. S. Levine, I. S. Fagerson, and E. A. Nebesky.) The effect of temperature and humidity is of considerable importance in the storage and "shelf-life" of packaged foods, particularly those with an original low moisture content. The relationship between the moisture content of a foodstuff and the equilibrium relative humidity when presented graphically is referred to as a moisture equilibrium curve or a sorption isotherm. Present methods of determining these curves are fairly complex and relatively little has been done with food products. A simplified procedure has been developed and is being evaluated against standard procedures. In addition moisture equilibrium studies are being conducted on various food products.

**Preservation of Sturgeon Roe (Caviar).** (A. S. Levine, C. R. Fellers, and A. Patron.) A detailed pasteurization procedure was developed for preserving Russian caviar in hermetically sealed glass containers. The maximum processing temperature at which quality could be maintained was found to be 155°F. The preserved product retained original quality as indicated by little or no change in color, texture, and flavor. The heat treatment was adequate to prevent spoilage through microbial action.

When preserved Russian caviar is held in storage for periods longer than a year at temperatures above ordinary room temperature, whitish irregular spots develop which resemble mold growth and detract from the product's appearance. Investigation showed that these spots consisted of crystalline tyrosine. It is recommended that pasteurized caviar be stored at cool temperatures to prevent this unsightly condition.

**Vitamin D Bioassay Research.** (L. R. Parkinson and C. R. Fellers.) There is still no adequate chemical method for the determination of vitamin D in many foods, particularly milk. Several of the proposed methods have been checked against the standard rat bioassay.

About 100 samples of vitamin D milk were examined this past year. Six samples were found to contain less vitamin D than was guaranteed on the cap of the bottle.

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## DEPARTMENT OF FORESTRY AND WILDLIFE MANAGEMENT
### R. P. Holdsworth and R. E. Trippensee in Charge

**Height-Strength Relationships on Plantation-Grown Red Pine.** (Alton B. Cole and J. H. Rich.) This study is a continuation of the work done by James M. Ring and J. H. Rich during 1947-48 on the effects of growth rate and varying wood densities of plantation-grown red pine on its properties and uses. Test specimens from 12 sample poles collected by Mr. Ring have been used, and samples taken from three distinct elevations in the stem have been subjected to breaking tests. Preliminary data evidence a pronounced reduction in specific gravity and percentage of summer wood with increase in height from the stump, which may indicate a reduction in strength. Numerous inquiries relative to the uses of red pine for tobacco posts, fence posts, and other products give importance to the study, which may result in a justification of increase in size specifications to provide satisfactory markets for this material. This study was supported by the American Creosoting Company.

**The Effects of Seedbed Treatment on the Natural Establishment of Eastern White Pine.** (Arnold D. Rhodes.) In August 1947, sixteen one-fortieth acre plots were established under an even-aged stand of eastern white pine approxi-

mately fifty years old, which because of poor form and quality was about to be clear-cut. Four conditions of seedbed were created as follows, each replicated three times: removal of the forest floor by burning, removal by raking, scarification of the floor by turning a tractor on one tread, and retention of the floor undisturbed (control).

A heavy seed crop borne that fall deposited seed at the approximate rate of 400,000 seeds per acre as determined by eight seed traps. The actual number of seeds which fell upon any one plot is not known. During the ensuing winter, the pine was harvested and all woody vegetation except the smallest shrubs was cut back to the ground. All cut material and logging slash were removed from the plots. Germination of seed and survival of seedlings were recorded at weekly intervals during the spring and early summer of 1948, and at longer intervals later. Preliminary results after the first year of observations are as follows:

1. Arrangement of treatments in decreasing order with respect to—
Germination: scarification, control, burning, raking.
Percentage survival: raking, burning, scarification, control.
Seedlings alive at end of growing season: scarification, raking, burning, control.

2. Germination was adequate by any form of treatment and does not appear to pose a problem. Conditions influencing survival are the critical factors.

3. Survival was favored by the development of herbaceous growth which protected seedlings against high temperatures. Such development was most rapid on raked plots, least on control plots, and intermediate on the others.

4. First-year survival was adequate under all forms of treatment except retention of the forest floor (control). Undisturbed litter without some form of shade such as brush or neighboring trees is unlikely to produce a satisfactory crop of seedlings.

The project is being continued to determine the effect of competition upon seedling survival—competition from both herbaceous growth and woody plants which are becoming established rapidly.

**Incidence and Control of Damage to the Northern White Pine by the White Pine Weevil, Pissodes Strobi.** (R. P. Holdsworth.) Since 1920 an annual coverage of Mt. Toby forest has been made for the removal of weevilled growth tips. An accurate count has been made and a graph plotted. Up to 1948 the trend of the curve was down, reaching practically zero in 1946. In 1948 the incidence of the weevil greatly increased, but did not reach the peak of 1920. The weevilled tips are collected and placed in wire cages which retain the weevil but allow the escape of possible parasites. Sufficient data have now been collected to support an attempt to correlate weevil incidence with weather and certain forest factors. Arising from this study has been the development of techniques making possible the substitution of an undamaged lateral for the weevil-destroyed leader, thus preventing forking and saving the forest value of the tree treated. The study is being continued and an attempt will be made to determine the spring emergence date of weevils which over-winter in the forest floor.

**Factors Affecting Damage to Communication Cables by Squirrels and the Possibility of Developing Means of Preventing Such Damage.** (Wesley R. Jones and R. E. Trippensee.) This is a continuation of the study of gray squirrel damage to lead-covered telephone cables, carried out in the previous year by Paul A. White. Work this year has been devoted to the testing of various styles of telephone cables with five squirrels, two males and three females, all on a complete diet. The cables include three sizes of a lead-covered cable, a lead cable

covered with glass fibre tape, and a polythylene-covered cable. Only one squirrel, a young female, did any gnawing damage to cables, this to a ½-inch lead-covered cable. The results obtained indicate that squirrels on adequate diet do little damage to lead-covered cables, and tend to confirm our previous conclusions that cable gnawing results from inadequate diet, probably lacking in calcium.

The study is being continued next year with fifteen squirrels, and an attempt will be made to so adjust their diet that gnawing damage can be caused or stopped at will. This project is supported by the Bell Telephone Laboratories of New York.

**Biological Conditions Relating to Reproduction, Development, and Growth of the Pheasant.** (Clark Corliss and Edward E. Pullen.) The embryology of the Mongolian pheasant was studied by Corliss, who is preparing his findings in the form of a thesis. His work indicates the possibility of producing and incubating pheasant eggs during the winter months under increased lighting. The forcing of pheasants by the use of lights is now being practiced on game farms. This study of pheasant embryology will help to explain some of the unknown aspects of pheasant ecology.

The occurrence and distribution of Argentaffin cells in the digestive tract of pheasants was studied by Pullen. The study showed the presence but unequal distribution of these cells in the pheasant. Argentaffin cells, the presence of which in the pheasant had not been demonstrated prior to this study, have no known function.

**Ecology and Economic Importance of the Bobcat.** (E. M. Pollack.) This study was started in September 1942 for the purpose of evaluating the economic status of the bobcat in the Northeast by analyses of food consumed, and of contributing additional knowledge on the ecology of this fur bearer.

Analyses of 224 stomachs and several hundred scats has yielded the most complete data available on food habits. Rabbits have proved the most important food item. Studies on 172 carcasses have given important information on size, age, sex ratio, and reproductive behavior. Original observations on the habits of the bobcat in its natural environment have been recorded by intensive field work.

Cooperators: U. S. Fish and Wildlife Service; Massachusetts Division of Fisheries and Game; The Wildlife Institute; University of Massachusetts.

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## DEPARTMENT OF HOME ECONOMICS NUTRITION
### Anne W. Wertz in Charge

**The Effect of Alcohol Consumption on the Utilization of Thiamine.** (P. Shaw and A. W. Wertz.) Reports in the literature and preliminary experiments in this laboratory indicated that alcohol when fed to albino rats exerted a sparing action on the use of thiamine by the animal. This subject has been further investigated in the past year. Results of this further work warrant the conclusion that alcohol *per se* does not affect the utilization or storage of thiamine in the body. It also appears that the metabolism of the amount of alcohol fed did not require an appreciable amount of thiamine.

**The Nutritional Status of Pregnant Women.** (A. W. Wertz, M. E. Lojkin, P. Shaw, G. C. Hagan, E. Morse, and C. Greenfield.) This project is being carried out as part of the Northeast Regional Cooperative Project on Nutritional Status as previously reported (Mass. Agr. Exp. Sta. Bul. 449 p. 58, 1948), and

with the cooperation of Dr. Eugene M. Holden of Amherst. Twenty-nine pregnant women have cooperated in the experiment to date. Preliminary data on the different phases of the study indicate some interesting observations.

*Dietary Studies:* Thirty-nine 7-day food records kept by the pregnant women under study have been obtained and checked by individual nutrients for their adequacy in respect to the Recommended Daily Allowances of the National Research Council. It was found that a very small percentage of the dietaries met the recommended daily allowances. None met the recommended daily allowance for thiamine, 2.5 percent for riboflavin, 2.5 percent for niacin, 64 percent for Vitamin A, 33 percent for ascorbic acid, 10 percent for calories, 5 percent for protein, 2.5 percent for calcium, and 5 percent for iron. It would seem from this information that the nutrient intake of these expectant mothers is sub-optimum according to our present-day standards.

*Blood Studies:* Blood samples are obtained from the pregnant women at three different times during the experiment and are analyzed for certain nutrients. Those samples obtained in the first half of pregnancy show that the largest number of the values for serum Vitamin A, serum protein, and hemoglobin fell within the range classified as fair. The largest number of values for carotene and ascorbic acid fell in the range classified as good. In all cases studied so far, the hemoglobin and serum protein values have increased considerably by the third month post partum.

No interpretation of the data obtained on the *urine studies* and the *physical examinations* has as yet been made. After the project is complete, correlations will be attempted between the data obtained in the four phases of study.

**A Study of the Methods for Obtaining Dietary Histories.** (G. C. Hagan, A. W. Wertz, P. Shaw, and C. Greenfield.) What technique to use is one of the major problems encountered in the planning of any study that necessitates obtaining an accurate picture of an individual's dietary. Many techniques are used by various workers in the field with very little scientific evidence to support the validity of any of them. The methods used involve different interview techniques, recall, and the keeping of a record of actual food eaten for varying lengths of time.

In this present study results obtained by some of these different methods have been compared, with the hope that the most suitable method might be determined. The data obtained by use of the dietary interview technique do not agree well with the data obtained from the records of the actual food eaten for a 7-day period. Indications are that the homemaker tends to overestimate her food consumption on the interview. Analysis of the data obtained from the food records show that a 5- or 7-day food record gives a much better picture of an individual's dietary history than one kept for a shorter time.

**Calculated vs. Analyzed Food Values.** (M. E. Lojkin, P. Shaw, A. W. Wertz, G. C. Hagan, C. E. Greenfield, and E. Morse.) In order to obtain some information on the validity of the food composition tables, used in the study on nutritional status for the calculation of dietary nutrients in the diets of the subjects, chemical analysis of 21 individual weighed 24-hour food intakes was made for certain nutrients. The values obtained by analysis were compared with the values calculated from the food composition tables. Although there is great variation in the individual food samples between analyzed and calculated values, the average values show good agreement for several nutrients studied. In all cases except two, the average analyzed values were higher than the average calculated values. Analyzed values for the fat and ascorbic acid were lower than

the calculated values by 10 and 17 percent respectively. Analyzed values for protein, calcium, phosphorus, thiamine, riboflavin, and niacin were higher than the calculated values by 3, 3, 5, 11, 31, and 15 percent respectively.

**Rodent Control Research.** (Leonard R. Parkinson.) During the past year experiments have been in progress to determine if possible the reason or reasons for the variation in toxicity ratings of identical samples of red squill. Several of these experiments are still in progress, but the data obtained to date seem to indicate that there is as much variation in susceptibility between the strains of test rats as there is within a single strain. The nutritional background was thought to be a factor. The several strains of test rats used received the same basal ration from birth and still this variation in susceptibility persisted. It now seems that a toxicity rating using the standard reference sample must be established for each strain of test rats in use. Then on subsequent testing one only needs to specify the strain of rats used when giving a toxicity rating.

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## DEPARTMENT OF HORTICULTURE
### Clark L. Thayer in Charge

**Study of Herbaceous Perennial Material.** (C. J. Gilgut and Paul Bobula, Waltham.) The test garden of perennials was maintained in presentable condition throughout the season and was visited by many people. It is the only one of its kind in New England, and if value of a project may be judged by the number who visit it and show interest in it, then the test garden is one of the most worth while. The numerous requests received indicate that the public is in need of the information on culture, ornamental value, uses, propagation, and sources of ornamental perennials which these test gardens furnish.

At present the garden contains more than 2200 of the better herbaceous perennials. Thirty-five did not survive the winter, although it was mild; seventeen were discarded because they were not true to name, were no longer available commercially, or had been superseded by better and more desirable varieties; and eighteen new varieties, not previously grown in the garden, were added during the season.

The phlox collection now contains many of the better varieties but is not complete and many more are needed for study.

The collection of hemerocallis is now in its second year and, although there has been some bloom, it will not be ready for evaluation until the plants are well established.

The aster collection, once the most extensive in the country, became a war casualty. It is now being rebuilt and already contains 36 of the better varieties in commerce. More will be added to make it again one of the best collections in the East.

Foliar nematode, one of the most serious pests of outdoor chrysanthemums, was not satisfactorily controlled by sodium selenate used as a soil drench or mixed with soil at planting time. Varying dosages and times of application were investigated. Nor did weekly spraying with DDT wettable powder, or dusting with DDT control this pest.

**Control of Weeds in the Nursery by Chemical Sprays.** (C. J. Gilgut, Waltham.) From May to November, Sovasol No. 5 was applied manually to weeds in the nursery, with a 3-gallon pressure tank sprayer equipped with a special nozzle which produces a flat fan-shaped spray. Manual application is desirable since

the oil is not sufficiently selective for indiscriminate application, and many nursery plants are highly susceptible to injury. A flat fan-shaped spray facilitates wetting the weeds without subjecting the nursery plants to injurious amounts of the weed killer.

Observations on tolerance to the oil were made on narrow-leaf evergreens, broadleaf evergreens, deciduous trees and shrubs, and herbaceous perennials. The narrow-leaf evergreens were represented by 7 species and varieties of Juniper; 6 of *Picea*, 4 of *Pinus*, 2 of *Abies*, 9 of *Taxus*, 6 of *Thuja*, and 4 of *Tsuga*. The broadleaf evergreens consisted of 21 species and varieties of 13 genera. There were also 15 species and varieties of deciduous trees, 31 of deciduous shrubs, and approximately 2500 perennials.

The narrow-leaf evergreens were injured less by Sovasol No. 5 than any other class of ornamental nursery stock. Of these the junipers were most resistant; less so were pines, spruce, hemlocks, fir and arbor vitae; and least of all *Taxus*. The foliage of *Taxus* is easily injured and if such spray wets the base of the trunk, or is allowed to run down the trunk to the roots, the plant may be killed. Deciduous trees and shrubs varied in the amount of oil that damaged the bark at the base of the trunk or stem, but the foliage on all was "burned" by small amounts of spray. This observation also applied to herbaceous perennials. Since foliage injury, particularly to salable-size ornamental plants, seriously impairs sale value, it is advisable that Sovasol No. 5 be applied in a manner that will cause a minimum of injury. At present the most practical method is by hand spraying when the weeds are small.

Preliminary trials for pre-emergence weeding of gladiolus bulblets indicated that this is a practical method to eliminate the first weeding. Later applications, after the gladiolus plants were up, were not feasible since the plants are badly injured by weed killers such as Sovasol No. 5.

Information obtained from this project was given to visiting nurserymen and others, by talking with them and by demonstrating the method of using Sovasol No. 5 to avoid injury to nursery plants. As a result, one progressive nurseryman used 2500 gallons in his nursery last summer. In one block of large arbor vitae on heavy soil, the overgrown weeds were first scythed down and then manually sprayed with oil at an estimated cost of one-third that of horse cultivating and hoeing by hand. Other nurserymen also have adopted this method of weed control, and it is gratifying that increasing numbers come here seeking information about it.

Studies are planned to determine the reaction of additional nursery plants to Sovasol No. 5; and susceptibility to injury on plants of different ages and in different stages of growth. Other weed killers will be tested for possible use in the nursery.

**Factors Influencing the Rapidity of Growth of Nursery Stock.** (C. J. Gilgut, Waltham.)

*Leaf Bud Cuttings of Rhododendrons.*—Leaf bud cuttings of 19 named varieties of hybrid rhododendrons were taken in June and August and propagated in sand and mixtures of sand–peat in proportion of 1:1, 1:2, and 1:3. The effects of rooting medium and six commercial root-promoting hormones were compared. The best rooting was obtained with Hormodin No. 2 powder treatment, and indolebutyric acid 60 mg. per liter for 24 hours. Sand–peat mixtures were better than sand alone.

There was a decided difference in varietal response to rooting. *Roseum elegans*, *album elegans*, Gomer Waterer, and Lady Armstrong rooted in larger numbers than the others.

*Rooting of Cuttings of Jane Abbott Azalea.*—The desirable pink azalea, Jane Abbott has resisted attempts to propagate it vegetatively. It failed to root in sand, sand–peat, cinders–peat, vermiculite, vermiculite–sand, and vermiculite–peat when cuttings were taken in mid-April. Treatments with commercial root-promoting hormones did not help.

If cuttings are taken at the right time they may root, and this phase will be investigated to a limited extent.

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## DEPARTMENT OF OLERICULTURE
### G. B. Snyder in Charge

**Asparagus Investigations.** (Robert E. Young, Waltham.) Considerable progress was made during the year in an experiment designed to develop a higher-yielding strain of asparagus. The third generation of plants was cut for the first full cutting period. The yield of spears from the best strain was slightly more than 1 pound per plant, as compared to 0.6 and 0.7 pounds per plant for the two commercial strains. When considered on an area basis, the yield of the better selections was almost double that of the commercial lines. This is due to a greater loss of plants in the commercial strains.

The increase in yield was obtained through a greater number of spears, not through larger size. Both the best selections and the commercial lines produced a crop which graded approximately 50 percent fancy; some smaller strains were as low as 32 percent fancy. The strains which produced the small-sized spears (average weight 16 gm.) came from parents whose average spear weight was 18 gm. The largest strains produced spears with an average weight of 20 gm., and came from parents which produced spears with an average weight of 27 gm.

There was considerable difference between strains in early production. As much as 25 percent of the total crop was harvested the first week from some, while others produced more nearly the same quantity for each of the six weeks cutting period. The earliness factor is important because of higher prices received at the beginning of the season. Early yield was not definitely associated with high total yield.

After the first full cutting season the number of stalks produced during the summer dropped 21 percent from the previous year. The better-producing strains did not show as much reduction as the low-yielding ones.

There was no loss of plants during the year. There was a heavy cover of snow over the plants all during the coldest weather, and this substantiates the theory that the loss of asparagus plants is due largely to winterkilling.

In the second generation planting the biennial bearing effect which has shown up the last few years was discontinued and the yields were the same as the previous year. The yield relationships between the strains remained the same as previously reported. No rust appeared on any of the plants.

**Vegetable Breeding for Improvement of Quality.** (Robert E. Young, Waltham.) Progress has been made in the development of strains of carrots and cabbage better adapted to local use. Work was along the lines previously indicated, but new developments are not conclusive enough to warrant detailed report at this time.

*Broccoli.*—Trials of fall broccoli, both at the Field Station and on growers' farms, again showed the value of the two strains developed for fall use. Broccoli is so easily affected by weather, and fall weather is so variable, that it appears questionable whether one strain of broccoli can be developed that will always be

superior. By using two strains of different environmental response, the grower can spread the risk. Neither Waltham 11 nor Waltham 29 has been a complete failure regardless of the weather, but this is not true of commercial strains. During the past fall, Waltham 11 produced more No. 1 broccoli than Waltham 29 or any of the commercial varieties. Sufficient seed of both Waltham 11 and Waltham 29 was distributed to growers to provide ample plants to determine the real value from a production standpoint. These strains showed up well, and the local market gardeners association is having seed produced for members.

Trials of selfed lines again indicated, as previously reported, that selfing, while improving uniformity, narrows the adaptability. Improvement is being continued by mass selection.

The spring crop of broccoli was almost a failure owing to an unprecedented infestation of clubroot and the ineffectiveness of the material used for cabbage maggot control. Sufficient selections were made to carry along the Waltham 7 material, but yield data were not available.

*Trellis Tomatoes.*—Because of the excessive rainfall during June, about half of the plants in the trellis planting were affected by root rots, and the plants were so stunted and delayed as to make yield data of questionable value.

Waltham Scarlet, the new variety developed for home garden use, met with a favorable reception and seed sales by one company were three times as much as during the previous year. While this variety is a little late for early trellis use, the high percentage of No. 1 fruits produced makes it valuable to growers as second early or fall crop. This variety won first prize for one grower in Field Day competition. Favorable comment has been received from its trials in other parts of the country, particularly Florida.

Both at the Field Station and on growers' farms, the results of trials of hybrid tomatoes developed at Waltham show all of these to have less tendency to set under adverse weather conditions than the standard varieties, such as Trellis No. 22 and Waltham Forcing. These hybrids have been developed for high early production of fruit but under the adverse conditions of last year they were not superior.

Early tomatoes have always been profitable, and since the weather during June is often adverse for setting a high percentage of the blossoms of the first and second cluster, a commercial hormone product for fruit setting was tried. These trials were made at the Field Station and on farms of two growers. Under the conditions prevailing on one grower's farm, two sprays applied to the blossoms a week apart resulted in an increase in set of the bottom cluster from 27 to 77 percent. The fruits ripe by July 30 were none for the check and 2.81 per plant where the sprays were applied. On the other farm, where the plants were not so vigorous, three sprays increased the set from 60 to 75 percent. Ripe fruit by July 30 was increased by the treatment from 1 to 2.78 per plant.

Two trials were made at the Field Station. On early plants the use of hormone sprays applied three times increased the set of blossoms from 62 to 84 percent. The yield of the sprayed plot at the first picking was almost three times that of the untreated, but the increase for the first two pickings amounted to only 8 percent. The application of three sprays to some later plants resulted in a reduction in the percentage of the blossoms set from 60 to 55 percent. However, the yield for the first two pickings was 51 percent greater from the sprayed plot than from the check. The hormone treatment caused a reduction in total yield in both trials.

If further trials confirm these results, the use of hormone to set the fruit in adverse weather will be well worth the cost.

*Greenhouse Tomatoes.*—Trials of tomatoes in the greenhouse have shown that a hybrid, Waltham Forcing X Michigan State Forcing, has consistently produced more fruit than Waltham Forcing and a higher percentage of No. 1 fruits. In the fall crop last year the hybrid produced 15.1 percent more No. 1 fruit and 6.9 percent greater total yield. Growers who have tried this hybrid have found it well worth while.

*Celery.*—As the result of single plant selections over a period of several generations, a strain of Summer Pascal celery has been developed, especially suited for use where celery is grown to maturity in the hotbed. It also has shown faster growth early in the season when the temperature is low. This celery has been developed in cooperation with a grower and is now ready for testing by others.

*Lettuce.*—The results of lettuce trials show that some progress is being made in the development of a better lettuce for Massachusetts. During the past year, the weather was so favorable as to bring about almost 100 percent heading in the set lettuce crop and thus afford little opportunity for selection. The lettuce crop seeded in the field headed at a time when the weather was warmer, and there were several strains and selections better able to withstand the warmer weather than the commercial varieties. Further work under more adverse weather will be necessary to complete selections.

Of the new varieties of lettuce tried, Premier Great Lakes produced well and was early. When planted later it tends to tipburn internally. Pennlakes showed up particularly well when seeded in the field. Both of these are recommended for trial by local growers.

The work of selecting a strain of Great Lakes lettuce adapted to local conditions has been started. Of the 10 strains tried from as many seed producers, none seemed to be alike and some were so different that they should be given other names or numbers. For the past two years there has appeared in the fields of Great Lakes lettuce when the plants were set early, a half-sized plant that is not sufficiently large for market. With the same seed, under warmer growing conditions, no small plants showed up. It is believed that these plants are particularly affected by cold weather. They have appeared in some strains up to 20 percent of the crop. Selection of the stock seed under warm California conditions is probably the cause, and a locally adapted strain would eliminate this loss.

*Butternut Squash.*—The program of developing a better Butternut squash has reached a point where inbred lines show no squash too long, while some commercial lines run as high as 12 percent. Other lines show no crooked squash, and the percentage of cull squash has been reduced from a normal of 25 percent to as low as 12 percent. Cracking of the fruit has also been reduced by selection. It is now the program to blend all of these characters into one strain and still maintain good yield, color, and shape.

Farmers always have had trouble getting Butternut squash seed to germinate satisfactorily during adverse weather. Experiments were conducted to determine what effect maturity and storage had on germination. It was found that the more mature the squash at harvest the better the germination of the seed. If the squash was mature, storage before seed removal did not increase germination; but with immature squash both seed weight and germination increased during storage.

In another test, squash which developed early, in mid-season, and late were so tagged. Seed was removed at early, mid-season, and late parts of the storage period. All of these lots of seed germinated over 96 percent in the laboratory. Also, they all germinated well in soil under favorable conditions; but when the

temperatures were lowered germination dropped, and only seed from those squash that developed early in the growing season and were stored to the mid-season or late period before seed was removed germinated satisfactorily. Further work is necessary to determine the conditions under which high-germinating seed can be produced.

**Weed Control in Vegetable Crops.** (William H. Lachman.) Hand weeding was eliminated in fields of set onions by the use of a 1½ to 2 percent spray of potassium cyanate applied when the weeds were dry and while they were quite small. Lamb's quarters and grasses become resistant to this treatment when they become larger than one half to three fourths of an inch tall. Three to four treatments were necessary throughout the season. Where the potassium cyanate was directed at the weeds so that the tops of the onion plants were not covered by the spray, yields were not reduced below those on carefully hand-weeded plots.

Pre-emergence application of several chemicals controlled weeds well for a period of four to six weeks in fields of sweet corn. The cheapest material used was 2,4-D; but it may damage corn or fail to kill weeds under certain conditions. Best results with 2,4-D were obtained with an application of 1½ pounds, acid equivalent, per acre, sprayed on land about six days after planting. Two other materials which appeared promising when applied immediately after planting are sodium pentachlorophenate (10 pounds) and Dow Contact Weed Killer (2 pounds DNOSBP).

Post-emergence applications of 2,4-D were not particularly beneficial since they had little or no effect on grasses, and such treatment made the corn stalks brittle and often prevented proper development of brace roots.

Dow Contact Weed Killer was outstanding in its effect on weeds in pre-emergence applications to snap beans. Two to three pounds of DNOSBP did not affect the yield and held weeds in check for four to six weeks.

Fall applications of isopropyl phenyl carbamate in spinach plantings left treated plots free of weeds the next spring without apparent harm to spinach plants. The control of chickweed with a 5 and 10 pound application of this chemical was especially noteworthy.

**Breeding Sweet Corn, Peppers, and Field Tomatoes for Massachusetts.** (William H. Lachman.)

*Sweet Corn.*—Nearly five thousand plants were self-pollinated during the year in the program to develop inbreds for the production of early types of Golden Cross Bantam sweet corn. These early types of P39 and P51 hybrids were developed by a backcrossing procedure and are now approaching uniformity. One hybrid involving this material as parents has the Golden Cross type of plant throughout and the ear matures in the Marcross season.

Gold Mine (Mass. 2410-191 x 63) continues to mature very early in competitive trials and about one ton of seed was sold to farmers this year. Work is in progress to improve the stiffness of stalk and ear appearance by using a three-way cross involving either C12 or C13 as the third parent.

One and one-half tons of Golden Jewel (2412-2 x 2412 1) x Maine 2 seed were produced and sold to farmers this year. This hybrid combines exceptional quality and appearance and matures in the Carmelcross season. Work is in progress in the attempt to advance its season of maturity somewhat.

*Peppers.*—Further trial indicates that Worldbeater selection III-1-1-3 is resistant to tobacco mosaic and is quite productive of very desirable fruit. Windsor Resistant selection I-1-4-2 is also mosaic resistant but did not yield well

during the past year. Several new selections from an $F_2$ population are very early in maturity although their disease resistance is questionable.

*Tomatoes.*—Several selections from a cross between Bounty and Stokesdale (32-1-2-2) produced a good yield of large, smooth fruits in season with Bonny Best. The fruits were covered well with foliage, and several strains are now quite uniform. The cross of Red Cloud by Pennheart provides a hybrid that is very early, although the cover of foliage is not sufficient. An $F_2$ population from this cross produced some very desirable early segregates.

**The Culture and Nutrition of Vegetables.** (William H. Lachman.)

1. A peculiar chlorosis on the leaves of greenhouse tomatoes is similar in its reactions to the chlorosis of plants affected by magnesium deficiency. Additions of potash definitely aggravated the condition; magnesium sulfate or dolomitic limestone plus additions of barnyard manure lessened or delayed it.

2. Several growth substances were found to set tomatoes, even where the flowers were emasculated before anthesis, and appear to have value for early planted crops where ordinarily the first blossoms often abscise. In dry weather, fruits set by means of these chemicals appeared to be more subject to blossom end rot than fruits set normally.

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## DEPARTMENT OF POMOLOGY
### A. P. French in Charge

**Influence of Chemical Treatments on Flowering and Fruiting of Fruit Trees.** (F. W. Southwick and W. D. Weeks.) In the spring of 1948 emphasis was placed upon the use of chemicals for thinning apples at blossom time and later. Since the dinitro materials are strictly blossom-thinning materials, the sodium salt of naphthaleneacetic acid (NaNAA) was used exclusively at calyx and up to 4 weeks from calyx. Also, attempts were made on Wealthy and Delicious to determine why NaNAA caused some flowers and young fruits to abscise and not others, and how soon after its application this increase in rate of abscission occurred.

Early McIntosh trees sprayed with 1 pound of DN-1 at blossom time or 8 ounces of NaNAA at calyx gave a larger yield of apples 2½ inches and up in diameter than hand-thinned trees. Total yield from the trees sprayed with DN-1 was also greater than that from hand-thinned trees. The trees receiving NaNAA, however, were more heavily thinned than those receiving DN-1 and had a smaller total yield than the hand-thinned trees. DN-1 resulted in more russeting and cracking and poorer finish than occurred on the hand-thinned or NaNAA-sprayed trees. However, NaNAA applied at calyx caused considerable curling and dwarfing of the spur foliage.

Wealthy spur flower buds 4.8 mm. in diameter and larger when dormant, set more heavily than those under that size, and NaNAA reduced the set much more markedly on those spurs bearing small flower buds. The period of increased rate of abscission on Golden Delicious, following applications of NaNAA at calyx and 4 weeks from calyx was not immediate. The fruit which was caused to abscise slowed down in its rate of enlargement and an increased rate of dropping did not occur until 9 to 12 days after the NaNAA was applied.

Somewhat to the surprise of the investigators, the McIntosh and Golden Delicious trees sprayed with NaNAA in 1948 at 2 and 4 weeks from calyx bloomed much more heavily this year than those spray-thinned at calyx with the same

material. The calyx-thinned trees bloomed only slightly more than the unthinned trees which produced only 5 to 10 percent of a full bloom. The explanation of these results is not entirely evident at present. Since late thinning (2 to 4 weeks from calyx) appeared to be considerably safer (from the standpoint of judging the extent of fruit set and foliage injury) than blossom or calyx applications of NaNAA, this finding may have considerable practical importance. Heretofore, it has been supposed that chemical thinning at calyx was more apt to result in annual blossoming than thinning done later.

Tests conducted in the spring of 1949 are located in 5 commercial orchards and at Amherst. After-calyx applications of NaNAA for thinning have been applied to Early McIntosh, McIntosh, Wealthy, Gravenstein, Duchess, Red Astrachan, Golden Delicious, Kendall, Baldwin, Rome Beauty, and Delicious. Some preliminary work covering late application of NaNAA on pears, peaches, and plums have been started.

Publication: Southwick, F. W., and Weeks, W. D. Chemical thinning of apples at blossom time and up to four weeks from calyx. Proc. Amer. Soc. Hort. Sci. 53:1949 (In press).

**Storage Investigations.** (F. W. Southwick, H. N. Stapleton, and F. Emmert.) Work in 1948 included the following:

1. Methyl naphthaleneacetate at concentrations of 1000 p.p.m. hastened the respiration, softening, and ground color development of harvested preclimacteric apples.

2. Harvested green tomato fruits appear to go through a well-defined preclimacteric, climacteric, and postclimacteric respiratory cycle which is similar to that of harvested preclimacteric apples. When red color appears the fruits are no longer preclimacteric. It is hoped that preclimacteric greenhouse tomatoes may serve as a substitute fruit for apples in respiratory studies of possible ripening inhibitors when preclimacteric apples are unavailable.

3. Concentrations of 1 to 5 gallons of Dowax 227 per 100 gallons of water as sprays or dips had no consistent influence on the rate of softening or scald development on apples. The same may be said of Plast-O-Trete at dilutions of 1 to 4 and 1 to 10 with water.

4. The use of activated carbon reduced storage scald of Cortland apples by 80 percent.

5. McIntosh stored at 5 percent carbon dioxide and 3 percent oxygen at 40°F. were slightly firmer when removed from storage in March than similar apples stored in air at 32° to 34°F. The apples from the modified atmosphere room remained marketable for 3 to 4 weeks when left at room temperature as compared to one week for the cold storage apples.

6. Lots of Howard 17 strawberries still showing white tips were subjected to temperatures of 34°F. and 50°F. in air and in one series to 15 to 20 percent $CO_2$ at 50°F. from 2 to 4 days (before being subjected to room temperatures), to determine how they compared with similar berries held at room temperature (70° to 90°F.) continuously. All refrigerated berries kept quite well for the short periods that they were under refrigeration and were markedly superior to unrefrigerated berries which were completely rotten in 2 to 3 days. The lots at 50°F. with 15 to 20 percent $CO_2$ were in somewhat firmer and less mature condition than those lots held in air at 50°F. and 34°F. when they were placed at room temperature. They remained marketable for ½ to 1 days longer than the other refrigerated lots, due largely to the fact that they rotted less rapidly. There was no marked difference in keeping quality between berries held for 2 days at 34°F. and those held for 2 days at 50°F.

Publication: Southwick, F. W. Further studies on the influence of methyl a-naphthaleneacetate on the ripening of apples and peaches. Proc. Amer. Soc. Hort. Sci. 53:1949 (In press).

**The Influence of Various Clonal Rootstocks on Apple Varieties.** (W. D. Weeks and F. W. Southwick.) For the first time since the orchard was planted in 1939 the McIntosh crop was large enough for comparisons of the effect of stock on yield. Trees on Malling IV and XV had significantly smaller yields than those on Malling I, II, III, V, XII, XIII, and XVI. Malling XVI produced the largest tree and crop. The crop on Malling I and II was nearly as large as that on XVI but tree size was intermediate. Trees on Malling XII were nearly as large as those on XVI but their average yield was considerably lower. Trunk cross-sectional area measurements of trees on Malling XV revealed that they are no larger than trees on V and III, although Malling XV is supposed to produce as large a tree as XVI.

**Study of Tree Characters of Fruit Varieties.** (W. D. Weeks, A. P. French, O. C. Roberts.) Buds of the Milton and Farmington strain of Black Tartarian sweet cherry were obtained from the Utah Station for comparison with Tartarian and false Tartarian which are grown by eastern nurseries. As one-year whips the Utah strains appear to be different from either of the two types of Tartarian grown by eastern nurserymen. This suggests that there is more than one type of sweet cherry being propagated for Black Tartarian.

New varieties of apple and pear were propagated for study.

The work of inspecting fruit tree nurseries for trueness-to-name was continued and 28 nurseries were inspected during the year. One nursery in Ohio was inspected for the first time. The number of misnamed trees found was no greater than that of past years. The prompt elimination of small mixtures prevents them from becoming larger and eliminates the danger of the grower obtaining a large number of misnamed trees.

**The Nutrition of Apple Trees.** (In cooperation with Chemistry and Agronomy.) (W. D. Weeks, F. W. Southwick, Mack Drake, Dale Sieling.) This project was initiated during the year to find out what effect different levels of nitrogen in the tree have on growth, yield, color, and keeping quality of fruit. Different levels of nitrogen will be maintained by soil applications of mulching materials, nitrogen fertilizers, complete fertilizer, and nitrogen applied as urea by foliar sprays. The effect of the differential fertilizer treatments on the chemical composition of the foliage will be determined by leaf analyses.

Leaf samples were collected from the midportion of the shoots of each of 125 fifteen-year-old McIntosh apple trees early in August, 1948, and analyzed for total nitrogen, phosphorus, potassium, calcium, and magnesium. Chemical composition of leaves and trunk diameters were used as a basis for pairing trees which constitute plots in the experiment, and also furnish a basis for studying effects of fertility treatments on leaf composition.

Initial surface and subsoil samples were taken.

The grass hay used for mulching had been field baled and varied considerably in nitrogen, phosphorus, potassium, calcium, and magnesium. The bales were broken, thoroughly mixed and rebaled with the result that the variation was reduced to about one-half that of the field-baled material. This hay was very low in calcium and magnesium, suggesting that applications of calcium-magnesium limestone may be required in orchards which receive mulch of this composition.

**Study of Bud Sports of the McIntosh Apple.** (W. D. Weeks and F. W. Southwick.) The 1948 crop from the orchard of 7 strains of McIntosh was in sufficient

quantity to permit a detailed examination of each strain. Amount and type of red color was studied. Strain R had the greatest amount of color; 92 percent of its crop had apples with 90 percent or more of red color.

Strain R was the only blush type which did not have some striped apples. Two-thirds of the crop from strain 12, a blushed type, was striped. The amount of striped fruit varied from 1 to 7 percent for the other blush strains. The apples of strain 39, a striped type, were all striped. From these results it appears that there may be superior strains of McIntosh insofar as type and amount of red color is concerned.

As soon as the crop is of sufficient volume, studies of preharvest drop, storage life, and quality will be made.

**The Nature of Winter Hardiness in the Raspberry.** (J. S. Bailey and F. W. Southwick.) Since 1944 an experiment has been carried on to compare cultivation with cover crops and hay mulch as cultural systems for red raspberries. In 1946 the cultivated plot was divided in half. One half received nitrate of soda annually at the rate of 225 pounds per acre; the other half at the rate of 450 pounds per acre. Likewise, the mulched plot was divided in half. One half received no additional nitrogen; the other, nitrate of soda annually at the rate of 225 pounds per acre. Differences in winter injury under the two systems of culture had been slight through 1945. From 1946 to 1948 differences began to show up in certain varieties. The two hardy varieties, Chief and Latham, were not injured severely and type of cultural treatment made no difference. The tender varieties, Marcy and Washington, were severely injured under both cultural systems. The varieties Milton and Taylor were injured much more severely under mulch than under cultivation. The differential fertilization with nitrate of soda appeared to have no effect on amount of winter injury. A paper, "Winter injury to red raspberries as affected by cultivation or mulching," by J. S. Bailey will appear in an early volume of the Proceedings of the American Society for Horticultural Science.

**Blueberry Culture.** (J. S. Bailey.) In the spring of 1948, in cooperation with Prof. A. I. Bourne, D-542 and D-289 were compared for the control of a Lecanium scale. D-542 was very effective. D-289 was less effective and was suspected of causing injury to the blueberry bushes. In the spring of 1949, D-289 was compared with tank-mixed superior oil. Both were effective in controlling the scale, but the superior oil was slightly better. Neither caused observable injury to the blueberry bushes.

In the spring of 1948, in cooperation with Dr. F. R. Shaw of the Entomology Department, the effect on bees of dusting blueberries with DDT while they are in bloom was studied. Adverse effects were slight, if any.

The blueberry stunt disease was watched for any additional evidence of its spreading. Three new cases, involving an additional variety, were found in the Station planting. A few new cases were found in the Cape Cod section. It is now evident that this disease is spreading slowly in Massachusetts.

There was considerable winter injury to cultivated blueberries in the Station planting during the winter of 1947-48. Varieties were rated as to winter injury as follows:

Very severe: Cabot, No. 73, Grover.
Severe: Sam, June, Scammell, Stanley, Pioneer.
Medium to severe: Adams, Burlington, Dunfee, Wareham, Dixi.
Medium: Pemberton, Concord.
Light to medium: Atlantic, Weymouth, Rancocas, Jersey, Rubel.
Light: Katherine.

Seven of the new U.S.D.A. selections fruited for the first time: DK-71, BM-22, A-91, T-72, X-58, DN-76, and U-25. While it is too soon to evaluate these, DK-71 looks the most promising at present.

**Nutrition of the High-Bush Blueberry, Especially in Relation to Soil Reaction.** (J. S. Bailey, C. Tyson Smith, and Robert T. Wetherbee.) The chemical leaf-analysis studies of 1947 were continued and expanded. Leaf samples were collected in July and in September from eight plantings in the Cape Cod section where the bushes were growing vigorously and bearing well. Samples were also collected from the Experiment Station plantings in Amherst. Again, the leaf content of P, K, Ca and Mg was found to be low compared with that of other fruits. Leaf nitrogen content was about what one would expect in apple leaves of normal vigor. From July to September P decreased; K was variable, increasing in some cases and decreasing in others; Ca increased; and Mg did not change significantly in half the cases, in the other half it increased.

Leaf analysis showed no increase in leaf Mg resulting from soil application of $MgSO_4$, but some increase resulting from spraying with $MgSO_4$. A report of this work, "The Nutritional Status of the Cultivated Blueberry as Revealed by Chemical Analysis," by J. S. Bailey, C. T. Smith, and R. T. Wetherbee, will appear in an early volume of the Proceedings of the American Society for Horticultural Science.

**Improvement of the Wild Low-Bush Blueberry.** (J. S. Bailey, W. D. Weeks, C. E. Cross, and F. R. Shaw.) This project was started in the spring of 1949. Emphasis is being placed on insect control, weed control, and fertilization.

Infestations of the blueberry flea beetle were light to very heavy in some locations in the Granville area. Parathion applied either as a dust or as a spray was very effective in controlling this insect and caused no observable injury to the blueberry plants. Very few adults emerged in places which had been treated during the larval stage. The infestation was spotty and many of these spot infestations were not found until blossom time. It was necessary to make applications during bloom, thereby endangering bees, in order to control the beetle larvae.

**The Effect of Benzene Hexachloride Sprays on the Flavor of Peaches.** (J. S. Bailey, W. B. Esselen, and E. H. Wheeler.) Since benzene hexachloride looked so promising for the control of curculio in peaches but had caused an off-flavor in some places, an experiment was set up in 1948 in a variety peach orchard to check on the production of off-flavor. A 50 percent wettable powder of benzene hexachloride containing 6 percent gamma isomer at 2 pounds per 100 gallons was applied to 36 varieties of peaches on May 29, June 3, and June 10. Tree ripened fruits were canned, frozen, and tasted as fresh fruit. No off-flavor attributable to BHC was detected in the frozen or fresh products. When canned, only 4 varieties showed no off-flavor. Detectable off-flavor in the other 32 varieties ranged from slight to strong and very strong. No correlation was observed between flesh color or season of ripening and the intensity of off-flavor. A report of this work, "Off-flavor in Peaches Sprayed with BHC," by John S. Bailey, William B. Esselen, Jr., and Ellsworth H. Wheeler will appear in the Journal of Economic Entomology.

**Control of Weeds in Fruit Plantings.** (J. S. Bailey.)

*Apples:* Sodium trichloracetate was applied at rates of 50, 100, and 150 pounds per acre to trees 25 years old and to trees the year after planting. About half the grass was eliminated by 50 pounds per acre; 95 percent or more by 100 or 150 pounds per acre. None of the concentrations produced any visible effect

on the older trees, but 150 pounds per acre appears to have delayed foliation slightly on the young trees.

*Blueberries:* Sodium trichloracetate was applied in August at rates of 37.5, 75, 112.5, and 150 pounds per acre. The lightest application caused a marked delay in foliation and failed to control grass. The bushes which received the heaviest application will probably die.

Bushes which received two applications of a proprietary mixture, containing 0.5 pound of dinitro-ortho-secondary butylphenol per gallon, at 3 gallons per 100, plus 10 gallons of fuel oil, to mow the grass and weeds showed no visible signs of injury.

*Peaches:* A proprietary mixture, containing 0.5 pound of dinitro-ortho-secondary butylphenol per gallon, at 3 gallons per 100 gallons of water, with and without 10 gallons of fuel oil, was tried for mowing grass. The fuel oil increased the effectiveness of the spray. No visible injury to trees occurred.

*Raspberries:* Sodium trichloracetate at 50 pounds per acre, applied in August, caused a marked delay in foliation in the spring of 1949.

Ammonium sulfamate, applied in late August at the rates of ¾ and 1 pound per gallon and 1 gallon per 100 square feet, eliminated all weeds except a few clumps of grass. Most raspberry plants appeared uninjured.

A proprietary mixture, AMCC, in fuel oil was no more effective than fuel oil alone. Another proprietary mixture, NIX, was ineffective.

*Strawberries: Fruiting bed.* Flowers were affected by 2,4-D at a concentration as low as 1 pound per acre. IPC (isopropylphenylcarbamate), broadcast dry at 5 or 10 pounds per acre, had no effect on either strawberries or weeds.

Stoddard Solvent at 100 gallons per acre was exceedingly toxic to strawberries. Dow Contact Herbicide was too toxic to strawberries, as was also phenyl mercuri acetate (PMA), even at a concentration as low as 1:8000. The addition of 2,4-D to PMA increased the toxicity to strawberries.

*Strawberries: Newly set bed.* Applications of 2,4-D at the rates of 1, 1½, 2, 4, and 8 pounds per acre were made before planting. Dry weather followed, and the treatments were not very effective in weed control. Four pounds per acre is too much for strawberries. Applications of 2,4-D made after the plants were set, following rain, were more effective in weed control.

IPC, broadcast dry at 5 pounds per acre, had no visible effect on either strawberries or weeds.

Ammonium sulfamate, applied before planting at rates of ½ or ¾ pound per gallon, 1 gallon to 100 square feet, was too toxic to strawberries.

PMA injured strawberries, even at 1:8000 concentration.

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## DEPARTMENT OF POULTRY HUSBANDRY
### F. P. Jeffrey in Charge

**Broodiness in Poultry.** (F. A. Hays and D. W. Talmadge.) Efforts are still being made to develop a completely non-broody line of Rhode Island Reds. The fact has been demonstrated that it is essentially impossible to develop a completely non-broody line by selective breeding because after many generations of selective breeding, the incidence of broodiness still stands at about 2 percent.

In the summer of 1947 the prolactin test was applied to all females in the non-broody line in an effort to locate the carriers of genes for broodiness. Results were not too satisfactory, very likely due in part to the presence of other hormones besides the prolactin fraction. Females that showed the least reaction to prolactin injections were used for breeding in the spring of 1948.

During the summer of 1948 prolactin was secured which was believed to be free of other hormones. Evidence was inconclusive that the prolactin hormone is a specific inducer of broodiness because not more than half of the control hens with broody history displayed broody behavior after receiving single or double doses of prolactin.

The last generation (1949) was hatched in part from two-year-old hens, some of which had been tested twice with prolactin and had given no evidence of broody behavior; and in part from yearling hens, all with one prolactin test and no broody behavior. No daughters from prolactin-tested dams have had time to complete their first laying year so that the value of this method of testing breeders is not yet determined.

The problem of deferred broody behavior is also being given further consideration so far as facilities will permit.

**Genetic Laws Governing the Inheritance of High Fecundity in the Domestic Fowl.** (F. A. Hays and D. W. Talmadge.) Changes in egg weight during the first laying year have been studied in six generations of Rhode Island Reds. The data show that egg weight normally declines after the maximum at the age of 10 to 11 months. There is a reduced feed consumption and a decline in body weight that do not appear to be associated with high temperatures. In this latitude the amount of decline in egg weight during hot weather is insignificant.

The Station flock of Rhode Island Reds has been bred without outside introductions for many generations, but close matings have been regularly avoided. The amount of inbreeding in the last five generations has been very slight, with a range from 2.85 to 5.33 percent, which is lower than would be expected by random matings where 35 to 40 families made up each generation. The data show that a pedigreed flock can be carried through many generations without inbreeding provided close matings are constantly avoided.

Viability in the flock bred for high fecundity has been given careful consideration. The highest mortality rate appeared during the month of June of the first laying year. In the last eight generations of pullets the mortality in June averaged slightly above 4 percent. The major causes of death were kidney and reproductive disorders.

Standards for selecting breeding females to raise the level of egg production have been given special consideration in eight generations of Rhode Island Reds. The data show that the flock was too small for further constructive selection and that the standards for progeny testing were too low.

Over a ten-year period the possible relation between family mortality rate and egg production of survivors has been studied. The data definitely showed that high mortality in families of chicks in the first eight weeks and in pullets between the ages of eight weeks and six months was consistently associated with high production of survivors. There was no association between mortality rate in families in the laying house and egg production of survivors for the first laying year.

Low house temperature has been shown to have a specific effect on egg production, but length of day appeared to have little effect.

Two new factors affecting egg production have been studied. It was noted that rate of production during the month of highest production was intimately

associated with production for the other eleven months of the pullet year. Rate of decline in production following the high month was also an important factor relating to egg production.

During a ten-year period low winter temperature has produced a higher incidence of winter pause but has not consistently increased the duration of pause. Viability as indicated by mortality rate in families does not appear to influence winter pause.

The importance of sustained high production in females has been demonstrated. Data show that those families that exhibit only a moderate decline in egg production from the first to the second laying year are superior for breeders. Such females are likely to give daughters with higher production and a lower mortality rate.

An examination of data on early embryonic deaths strongly indicates that female embryos die at a more rapid rate than males during the first eight days of incubation.

**A Study of Fertility Cycles in Males.** (F. A. Hays and D. W. Talmadge.) During the spring of 1949 all-night lights for 30 days, morning lights at 4 a.m. for 7 weeks, and no artificial lights (control) were used as treatments to activate 24 to 36 months-old males to higher fertility. The data showed the two methods of lighting to be about equally effective and both treatments superior to natural light only. Further data are necessary to determine whether a longer period of all-night lighting would be advantageous.

The inheritance phase of fertility in Rhode Island Reds has been further examined over a ten-year period. The data are strongly suggestive that sex-linked genes are operating to regulate fertility.

**Secondary and Adult Sex Ratio in Relation to Hatchability.** (F. A. Hays.) The fifth generation of selection to produce high and low hatchability lines has been produced. The two lines are definitely diverging but there are still a few females that fail to qualify according to the standards. The search for lethals producing low hatchability has continued.

Definite evidence has been presented showing that hatchability tends to decline as the parents grow older. This tendency is more pronounced in females than in males. One of the potent causes of this decline is increased early embryonic mortality. There is also an increase in the number of live chicks that fail to emerge from older parent stock.

**Breeding for High and Low Incidence of Internal Defects in Hen's Eggs.** (F. P. Jeffrey and C. E. Walker.) Among $F_1$, $F_2$, and backcross ($F_1$ male x S.C. Rhode Island Red females) egg shell color segregates from reciprocal matings of S.C. White Leghorn and S.C. Rhode Island Red, it was found that the groups with the darkest egg shells carried more colored meat spots and fewer white meat spots than did the groups with tinted or white egg shells. These observations agree with previous findings taken within and between breeds.

**Breeding White Plymouth Rocks for Eggs and Meat.** (F. P. Jeffrey.) Observations on brooding house mortality (up to 6 weeks of age) over a five-year period indicate that the re-use of litter cannot be recommended for the grower of replacement pullets. It is true that strains can be "acclimated" to filthy brooding, but at the present time this has not been generally accomplished. Likewise there is real danger of increasing mortality from lymphomatosis on the range and in the laying house by the re-use of litter. It is desirable, however, for breeders to use litter over and over again. This is especially desirable for the breeder of "broiler" stock.

## SEED CONTROL
### Frederick A. McLaughlin in Charge

Enforcement of the Seed Law, together with the desire of seedsmen to comply with requirements of this Act and a growing interest of the public in good seed, has greatly increased the number of service samples sent to the seed laboratory for testing. From July 1, 1948, to June 30, 1949, 7416 service and inspection samples of seed were received and worked at the laboratory, an increase of 458 over the previous year. The laboratory also received and cleaned 95 lots of tobacco seed.

Analysis of inspection samples shows that most seedsmen have complied with label requirements of the Seed Law. A large part of the violations found are technical in nature rather than flagrant.

Operation of the Seed Law is reported in an annual bulletin issued for that purpose.

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## DEPARTMENT OF VETERINARY SCIENCE
### J. B. Lentz in Charge

**Poultry Disease Control Service.** (H. Van Roekel, K. L. Bullis, G. H. Snoeyenbos, O. S. Flint, F. G. Sperling, M. K. Clarke, O. M. Olesiuk, A. M. Crotty, S. M. O'Grady, and A. C. Haskell.)

1. *Pullorum Disease Eradication.*—During the 1948-49 testing season, 569 chicken, turkey, and pheasant flocks were tested in 12 counties. A total of 1,241,500 samples was tested, of which only 0.04 percent were positive. This is the lowest percentage of positive tests for the 29 years of testing. No reactors were detected among fowl other than chickens. The percentage (1.55) of breaks in the negative flocks was the lowest in the last ten years of testing. Furthermore, 99.1 percent of all the birds tested were located in 100 percent tested, nonreacting flocks. Only five flocks were classified as infected at the close of the testing season.

The results reveal that further progress is being made in the eradication of pullorum disease from Massachusetts flocks. A more detailed discussion of the pullorum testing work will be given in the Twenty-Ninth Annual Report of Pullorum Disease Eradication in Massachusetts.

2. *Salmonella Pullorum Studies.*—During the past year 20 pullorum-infected flocks were detected through the testing and diagnostic services. A total of 94 infected birds was submitted to the laboratory, from which 275 *S. pullorum* cultures were isolated. An additional 69 suspicious reacting birds were examined and found to be negative. All cultures were extensively studied in regard to their antigenic composition and behavior. Only three mature birds obtained from two flocks were found to be infected with the antigenic variant form of the organism. These were the only infected birds in the flock and were readily detected by the standard antigen used in routine testing.

Six infected chick and poult flocks were found, which appeared to be infected with both the standard and variant forms of the organism. No flocks were found in which only the variant type was recovered.

Extensive investigation of the relationship between the antigenic form of the infecting organism and the agglutinating components of the serum from the corresponding bird has yielded valuable information concerning pullorum disease control methods. Part of these results are in the process of publication.

With this information, it is hoped that an antigen may be developed which will be more effective in detecting birds infected with the recognized antigenic forms than the one employed for routine testing at the present time. To date the results appear very promising for developing such an antigen.

3. *Diagnostic Service.*—During the 1948 calendar year, 5,180 specimens were received in 1,068 consignments, of which 742 were delivered in person. The specimens were classified as follows:—4,806 chickens, 275 turkeys, 26 quail, 13 canaries, 11 each of canine feces and guinea pigs, 8 equine feces, 5 pheasants, 4 bovine, 3 porcine, 2 each of chinchillas, mink feces, mink, and pigeon, and 1 each of cedar waxwing, fowl pox vaccine, goat feces, hamster, junco, lynx rufus, rabbit, raccoon, robin, and ruffed grouse.

The continuing increase in the amount of material coming to the laboratory for examination was due largely to the great demand for immunity tests for the purpose of having flocks included in the infectious bronchitis and Newcastle disease immunization programs. This is to be expected since infectious bronchitis and Newcastle disease are of great economic concern to the poultry industry. These two diseases are discussed further in another section of this report. Tumors (109), coccidiosis (102), and fowl paralysis (71) were other prevalent disorders as in previous years. Avian tuberculosis was identified in one flock. There were 21 diagnoses of fowl typhoid and 15 of fowl cholera, 14 and 9, respectively, representing new known foci of infection. The incidence of epidemic tremor and of nutritional encephalomalacia was considerably higher than that of the previous year.

Additional observations on the kerato-conjunctivitis in chickens reported a year ago suggest that ammonia fumes from the litter might be the causative factor. Attempts to transmit the disturbance by pen contact and transfer of material to the eyes of laboratory chickens have failed. Reports on affected flocks also indicate that no infectious agent is present.

The 275 turkeys were received in 59 consignments. This represents a further decline in the number of specimens being submitted to the laboratory and reflects in part a more stable situation in the turkey industry. Only one diagnosis of paratyphoid was made as compared with an average of ten for each of the preceding four years. Fowl pox and hexamitiasis were not identified for the third succeeding year. Two outbreaks of Newcastle disease in growing birds were detected. Penicillin was used to treat infected individuals in two outbreaks of erysipelas. Of the 72 birds treated in the first outbreak, 10 (13.9 percent) died. There was a mortality of 43 birds in a flock of 900 over a period of three weeks. Another group of 700 in an adjacent lot did not become infected when added to the first lot of 900. In the second outbreak, 29 (20 percent) of 145 treated birds and 5 (33 percent) of 15 clinically affected untreated controls died. There was a mortality of 85 birds in the flock of 3,000 over a period of 10 days.

4. *Flock Mortality Studies.*—Necropsies were made on 194 birds (152 females and 42 males) up to January 1, 1949, from the flock hatched in the spring of 1947 and maintained for genetic studies by the Poultry Department at the University. Infectious bronchitis was identified in the flock for the first time in September, 1948. The effect on egg production in the birds under consideration could not be accurately assessed as they were completing their first laying year and were relatively low in production. The egg production, which had reached 50 percent in a group of birds just beginning to lay, dropped to 16 percent within one week and remained below the pre-outbreak level for a period of more than two months; whereas the effect on birds about a month younger, which had not started to lay, was negligible. The egg shape and the shell texture did not regain normalcy for approximately three months in the adversely affected group. Reproductive

disorders, cannibalism, tumors, and kidney disorders were the principal causes of mortality in the flock. Gross examination indicated that the incidence of lymphocytoma (14 females and 1 male) and fowl paralysis (12 females and 1 male) was increased considerably over the previous year when four cases of each were recognized.

5. *Infectious Bronchitis Control.*—Respiratory diseases, especially infectious bronchitis and Newcastle disease, are of great economic concern to Massachusetts poultrymen. During 1948 a total of 434 flocks was enrolled in the infectious bronchitis control program, an increase of 171 flocks over the previous year. The results on the whole continue to be satisfactory, although an apparent break in the immunity occurred in a few flocks. Such cases will be investigated more thoroughly if they occur again.

During 1948 a total of 262 consignments was submitted for immunity tests for differential diagnosis of infectious bronchitis and Newcastle disease. Diagnosis for infectious bronchitis showed 227 positive, 4 doubtful, and 31 definitely negative. Six consignments, five positive and one negative, were from out-of-state flocks. A total of 968 serum-virus neutralization tests was conducted for infectious bronchitis diagnosis.

Of the 262 consignments which were submitted for differential diagnosis, 90 were positive for Newcastle disease, including one from out of state. Of the 239 consignments submitted for Newcastle disease diagnosis only, 83 were positive, 9 questionable, and 147 negative. A grand total of 173 positive diagnoses of Newcastle disease was made during 1948.

Eighty of the consignments submitted for differential diagnosis, were found to be positive for both infectious bronchitis and Newcastle disease.

6. *Newcastle Investigations.*—(a) During the past year studies on the use of live vaccine for immunization against Newcastle disease were continued. A total of 230 flock owners was supplied with the Massachusetts vaccine for Newcastle disease immunization. Approximately 770,000 birds were vaccinated. On the whole, the results were quite satisfactory. However, in the vaccination of commercial flocks it appears that live Newcastle vaccine must be prescribed with caution to the owner, since it may produce severe outbreaks in young chicks and may markedly affect egg production in laying birds. Even in growing birds, a mild to moderate outbreak may follow vaccination. Similar observations have been made regarding the use of commercial live vaccines. To reduce or eliminate these post-vaccination difficulties, the live vaccines need further investigation. The immunity produced following vaccination apparently is adequate to prevent natural outbreaks of the disease. Natural outbreaks have not been detected in vaccinated flocks up to the present time.

Simultaneous vaccination with fowl pox and Newcastle disease vaccines has also been investigated. Laboratory trials have given satisfactory results. In some cases in the field severe post-vaccination troubles have developed. However, it was difficult or impossible to determine whether the troubles were caused by the dual vaccination or might have occurred if the birds had been vaccinated only with the Newcastle vaccine. Age, health of the flock, and seasonal factors play a decided role in the post-vaccination results.

(b) Passive immunity to Newcastle disease in progeny from stock immunized either through natural infection or by vaccination was studied. Field observations have revealed that chicks from immune stock may contract the disease as early as six days of age. In limited laboratory trials, chicks from vaccinated stock did reveal a limited degree of immunity at nine days of age. These studies are being continued.

(c) Viability studies concerning Newcastle disease were initiated during 1948. An embryo-adapted strain of virus was tested for its viability when placed in contact with various materials and stored under a wide range of temperatures. Preliminary results indicate that Newcastle disease virus may be quite resistant when subjected to certain environmental conditions.

(d) Transmission of Newcastle disease virus through the egg was investigated. Previous studies failed to show transmission of the disease to chicks hatched from eggs obtained from flocks with active outbreaks of the disease. In a limited number of trials, eggs inoculated with Newcastle virus, of known pathogenicity for live birds, likewise failed to hatch chicks affected with Newcastle disease. It appears that Newcastle disease infective eggs are not apt to hatch infected chicks. The greatest source of danger appears to be that eggs containing the virus, if broken in the incubator or hatchery, might cause infection in young chicks.

**Mastitis Testing Laboratory.** (W. K. Harris and F. A. Goulet.) During the fiscal year of 1948-49 a total of 29,059 milk samples was tested, which is more than twice the number tested during the previous year. Of the total number, 18,806 were from 21 State institution herds, 1,159 from the University Farm Department herd, and 9,094 from 140 private herds. Included in the latter were 309 samples from one county agricultural school herd and 832 from three demonstration herds. In addition to the total number of samples tested, 125 were received in a condition unsuitable for testing.

The three demonstration herds were tested in cooperation with the current program of the Extension Service to establish a mastitis control demonstration herd in each county. The total number of cows on the initial test of these herds was 52. Of these, 20 (38.5 percent) were classified as negative, 23 (44.2 percent) as positive for mastitis not due to *Str. agalactiae*, and 9 (17.3 percent) as positive for infection with *Str. agalactiae*. Progress in control is favorable, but conclusions cannot yet be drawn.

A summary of initial tests of private herds revealed a lower percentage of infected cows (43.4 percent as compared with 48 percent last year), the greatest reduction occurring in the number of *Str. agalactiae*-infected cows in herds having 20 or more cows. A total of 239 reports was made on samples from private herds. Of the private herds tested during the year 38 percent have had more than one test.

The incidence of mastitis in the State institution herds as a group is less, the greatest reduction being in the number of *Str. agalactiae*-infected cows (22 percent as compared with 38 percent last year). This improvement can be credited to 7 of the 21 herds. Four other herds are free from infection with *Str. agalactiae*, one having been maintained free for more than two years, and two for more than one year. The University Farm Department herd is also free from *Str. agalactiae* infection and has been maintained thus for more than one year.

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## WALTHAM FIELD STATION

Waltham, Massachusetts

Ray M. Koon, in Charge

The members of the research staff of the Waltham Field Station are assigned to this branch by the Departments of Botany, Entomology, Floriculture, Horticulture, and Vegetable Gardening. Refer to reports of these Departments for results of investigations conducted at this Station.

## PUBLICATIONS

### Bulletins

437 Home Freezing in Massachusetts. By William B. Esselen, Jr., Katherine M. Lawler, and Carl R. Fellers. 35 pp. illus. November 1948. (Revised.)
Home freezing of foods is arousing much interest. In Massachusetts freezing seems best suited as a supplement to other methods of home preservation. Questions frequently asked by prospective home freezer owners are answered.

445 Cranberry Insects in Massachusetts. By Henry J. Franklin. 64 pp. illus. January 1948.
Insects take an annual toll of fully one-fifth of the cranberry crop in Massachusetts. Information essential for their control is herewith provided.

449 Annual Report for the Fiscal Year Ending June 30, 1948. 80 pp. illus. September 1948.
The main purpose of this report is to provide an opportunity for presenting in published form recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

450 Weather in Relation to Cranberry Production and Condition. By Henry J. Franklin and Chester E. Cross. 16 pp. July 1948.
Weather studies have been continued at the Cranberry Station since Bulletin 433 was issued in 1946, and the results, presented here, seemed to justify prompt publication.

451 Weed Control in Vegetable Crops. By William H. Lachman. 60 pp. illus. September 1948.
Weeds compete seriously with crop plants for moisture, nutrients, light, and air, and also add greatly to the labor needed for crop production. This bulletin presents the results of recent experiments in weed control which are pertinent to the culture of vegetables as they are grown in Massachusetts.

452 The Inheritance of Certain Fruit and Foliage Characters in the Peach. By John S. Bailey and Arthur P. French. 31 pp. illus. May 1949.
The demand for better varieties is as old as peach growing. Lack of basic genetic information, however, has made the production of new varieties a slow trial-and-error process. The work reported herein was undertaken to supply some of this basic information as to how characters are inherited.

### Control Bulletins

136 Inspection of Commercial Feedstuffs. By Feed Control Service Staff. 24 pp. June 1948.

137 Inspection of Commercial Fertilizers and Agricultural Lime Products. By Fertilizer Control Service Staff. 16 pp. July 1948.

138 Twenty-eighth Annual Report of Pullorum Disease Eradication in Massachusetts. By the Poultry Disease Control Laboratory. 11 pp. July 1948.

139 Seed Inspection. By Seed Control Service Staff. 36 pp. November 1948.

### Meteorological Bulletins

715-723, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By H. N. Stapleton. 4 pp. each.

## Reports of Investigations in Journals

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628 Spontaneous lymphocytoma in a flock of chickens. By Carl Olson, Jr. Amer. Jour. Vet. Res. 9 (31):198-200. 1948.

629 Influence of light during storage on composition of Blue Hubbard squash. By Arthur D. Holmes, Albert F. Spelman, Charles J. Rogers, and William H. Lachman. Food Res. 13 (4):304-307. 1948.

630 Composition and nutritive value of fresh, cooked, and processed swordfish. By Antonio Lopez-Matas and Carl R. Fellers. Food Res. 13 (5):387-396. 1948.

634 A gauge tester for home pressure canners. By C. I. Gunness and C. R. Fellers. Food Res. 13 (4):336-339. 1948.

635 Estimation of polyuronide hemicelluloses in holocellulose from nonwoody plant material. By Emmett Bennett. Analyt. Chem. 20:642-643. 1948.

639 Effect of decomposition of added oat straw and alfalfa meal on solubility of soil copper in ammonium acetate. By Charles Hurwitz. Soil Science Soc. Amer. Proc. 12 (1947):195-197. 1948.

640 Density of feather pigment in Rhode Island Reds. By F. A. Hays, Carol H. White, and Ruby Sanborn. Amer. Nat. 82:107-117. 1948.

642 Simplified Blacet-Leighton apparatus for gas microanalysis. By Victor M. Lewis. Analyt. Chem. 21:635. 1949.

647 Changes in the egg weight of Rhode Island Red females during the first laying year. By F. A. Hays. Official Report of the Eighth World's Poultry Congress, pp. 151-158. 1948.

649 Effect of different processing procedures on venting and loss of liquid from home canning jars. By W. B. Esselen, Jr., and C. R. Fellers. Food Tech. 2 (3):222-227. 1948.

653 Storage losses of Butternut squashes. By Arthur D. Holmes. Food Res. 13 (6):497-502. 1948.

654 Some results of hormone treatment of field-grown tomatoes. By Arthur D. Holmes, C. Tyson Smith, John W. Kuzmeski, and William H. Lachman. Food Tech. 2 (3):252-255. 1948.

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659 Further scion and stock combinations with Spy 227. By W. D. Weeks. Amer. Soc. Hort. Sci. Proc. 52 (1948 : 137-140. 1949.

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